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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

APRIL 4.

Sheffield Metallurgical Association:—Meeting at Sheffield. "Abnormal Case-Hardening Steels," Paper by Prof. F. C. Thompson.

APRIL 6.

Society of Chemical Industry (Birmingham and Midlands Section):—Annual meeting. "Refractories," Paper by C. R. F. Threlfall and A. T. Green.

APRIL 11.

Institution of Engineers and Shipbuilders in Scotland:—Annual general meeting at Glasgow. "Mechanical Ability," Paper by C. A. Oakley.

Institute of British Foundrymen.

APRIL 1.

East Midlands Branch (Lincolnshire Section):—Ordinary meeting at Lincoln. "The Sand-Slinger in the Foundry," Paper by A. J. S. Shewan and R. Atchison.

Lancashire Branch:—Annual general meeting at Manchester. "The Making and Use of Graphs for Foundry Purposes," Paper by J. S. G. Primrose.

West Riding of Yorkshire Branch:—Ordinary meeting at Bradford. "Grey-Iron Castings," Paper by F. K. Neath and F. Poole.

APRIL 5.

Lancashire Branch (Preston Section):—Meeting at Preston. Annual general meeting.

APRIL 7.

Birmingham and Coventry and West Midlands Branch:—Annual general meeting at Birmingham.

Middlesbrough Branch:—Annual general meeting. Discussion and Films of Interest.

The Blind Spot.

An engineering contemporary has asked the question why it happens that sometimes outsiders can give good and useful advice about businesses directed by capable men, who see the advantages of new methods immediately these are laid before them. The question arose out of a statement that an outside psychologist had made a saving in a works through re-grouping machines, so that a smaller number was held up in the event of a breakdown to one of them. Obviously, it should not have needed a psychologist to find that out. Doubtless the feeling that new blood is sometimes beneficial arises from a similar state of affairs. The benefit derived by those in industry from contacts with similarly-engaged persons, through the technical institutions and their conversations with the officers of such bodies and research associations, arises from the same cause—that the onlooker frequently sees most of the game. It is also allied to the impression that a prophet has no honour in his own country. A managing director, conscious of the weaknesses as well as the strength of his subordinates, will frequently delay adopting a recommendation from one of them because he subconsciously feels the need for independent confirmation that the suggestion is sound. By the circumstances of the case this can frequently never be obtained, with the result that the development drags, the proposer is discouraged and everybody tends to allow things to remain as they are.

We remember once hearing a story to the effect that a railway company employed an able young graduate from one of the older universities to go about the system for the purpose of suggesting improvements, to the need for which custom had blinded the ordinary staff. One of his suggestions, perhaps the only one, was that on carriages and wagons the last letter of the railway's initials should be dropped, because everybody knew it was a railway. The result in the saving of paint was considerable, but again one feels it should not have needed an outsider to point out a thing like that.

Another difficulty which affects this psychological issue is that so much of the advice available to-day in industry is not disinterested. Many experts are willing to re-plan a works or reorganise a business around equipment or machinery which they can recommend in connection with it. When a truly independent consultant, or a person with special facilities for watching the trends in industry, gives his advice it is particularly valuable, and all the more so because it is often unpalatable to those to whom it is addressed. As our contemporary suggests, the problem is allied to the one which results in the cobbler's children being the worst shod. Some of the failures in organisation occur in works run by men who are known to be keenly interested in organisation and planning.

It's Up to You!

The scheme envisaged by Prof. Andrew for the creation within the Metallurgical Department of Sheffield University of a degree course in foundry practice has been approved by the authorities; it is now left to the foundry industry to find the necessary finance. It is, of course, well known that the fees payable for courses at universities do not cover the expense involved in giving the tuition, and much additional income is essential. It is proposed that there should be an advisory committee formed which would be composed of members of the industry and, of course, the educational authority. In making this appeal to the individual foundry owners of Great Britain, we want to stress that such degree courses exist in both France and Germany, and the industrialists of those countries have repeatedly assured us in the most enthusiastic terms of the benefit that they as individuals have derived from their personal support. They certainly had to wait for about three years, but once a supply of university graduates was available to help them in the conduct of their works, they were particularly anxious that this supply should be maintained. Otherwise, they found themselves at a disadvantage in interpreting and commercialising the results of research. At the moment, sons of foundry owners are being trained at home and abroad in either engineering or metallurgy or in some cases pure science; this involves a longer period of training, extra expense and withal an incomplete training. In general terms, if the foundry industry is to keep abreast of modern developments, to combat the inroads made by weldings, plastics, forgings, and so on, it is essential that it legislates immediately for the supply of a type of mentality which a modern university is especially well placed to provide. Any foundry executive who requires further information as to the scheme should write to Dr. Andrew.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Balanced-Blast Cupola.

To the Editor of The Foundry Trade Journal.

Sir,—In your issue of March 16, Mr. E. A. Roper asks for "the coke consumption per ton of metal charged in a balanced-blast cupola rated at, say, 4 tons per hr. and melting 6 to 7 tons per day, the figure to include bed coke."

About this time last year we decided to convert a 4-ton cupola to the balanced-blast system. Whilst the necessary parts were being prepared, we made close observations upon the operation of the cupola and obtained comparative figures for a like number (over 50) of heats before and after the conversion of the cupola.

The average size of heat was 13.25 tons for the heats before conversion and 11.2 for those after conversion. These are considerably greater than Mr. Roper mentions; as for the small quantity of metal mentioned in his letter (6 to 7 tons), we should work a smaller cupola. *We found a saving of about 20 per cent. of the total quantity of coke used.* The general impression in the foundry is that the metal is hotter and there has been a distinct decrease in the number of castings defective, owing to gas-holes.

We shall be pleased to show this cupola to Mr. Roper or anyone interested in the balanced-blast development.—Yours, etc.,

D. M. Semple, Director.

The Mirrlees Watson Company, Limited,
Glasgow.

March 21, 1933.

To the Editor of The Foundry Trade Journal.

Sir,—Further to my letter of March 18, I am now able to give additional particulars of coke consumptions on a small balanced-blast cupola, melting a limited tonnage per day, following Mr. Roper's inquiry in your issue of March 16.

The following figures refer to a 24-in. bore cupola, rated at 2.4 tons per hr. and actually yielding 3 tons per hr. The average melt is about 2.5 hrs., the average tonnage per day being 7.5. The bed charge is 4.5 to 5 cwts., of which 2 cwts. is recovered and re-used. The average bed charge is taken as 3 cwts.:—

Coke consumption, including bed, 9.45 per cent., or 10.6:1.

Coke consumption, excluding bed, 7.45 per cent., or 13.4:1.

The member adds that varying amounts of steel are used, but this does not seem to make any difference to the coke consumption. The tapping temperature is 1,500 deg. C.—Yours, etc.,

J. G. Pearce, Director.

The British Cast Iron Research Association,
St. Paul's Square, Birmingham.

March 23, 1933.

Estimating Molybdenum in Cast Iron.

To the Editor of The Foundry Trade Journal.

Sir,—In view of the use of molybdenum in cast iron, the following notes on analysis may be of interest. Some difficulty was recently experienced with molybdenum cast iron on applying the usual method for steel analysis to estimate the molybdenum.

Experiments were made, and it has been clearly shown that after separating the iron by dropping the solution into hot caustic-soda solution, it is necessary to add ammonium chloride before precipitating the lead molybdate in order to avoid precipitating lead phosphate. In steel, the amount of phosphorus is trifling, and the amount of salts present is adequate, but cast iron usually contains a considerable amount of phosphorus and the addition of 20 gms. ammonium chloride is necessary to hold up the lead phosphate.

(*Concluded in next column.*)

Refractories Association's New President.

Mr. H. W. Winterton, who was installed President of the Refractories Association last Friday, is well known throughout the foundry industry as chairman of Messrs. William Cumming & Company, Limited, of Glasgow. Mr. Winterton has already established his popularity as a chairman, for in 1929 he presided, with distinction, over the Scottish Branch of the Institute of British Foundrymen, and was also at the same time President of the Foundry Equipment and Supplies Association. Though obviously a very busy industrialist, he devotes some of his limited leisure to municipal matters, and represents his home ward on the Milngavie Council. His many friends in the foundry industry will join with us in wishing him every success during his term of office in his new capacity.

Mr. H. W. Winterton.

(*Concluded from previous column.*)

(1) It was found that, on dissolving pig-iron and cast iron in hydrochloric acid, most of the phosphorus remains in solution, *e.g.*, a pig-iron containing 1.10 per cent. yielded 0.97 per cent., and a cast iron containing 0.55 per cent. gave 0.41 per cent. This high proportion was not previously realised.

(2) The separation from iron with caustic soda also separates the phosphorus quantitatively, which was not expected.

(3) On precipitating the lead molybdate without addition of ammonium chloride, nearly the whole of the phosphorus was found in the precipitate. (The sample had been dissolved in hydrochloric acid.)

This matter is of interest on account of the desirability of accurate analysis in dealing with an expensive alloy.

At the same time, it would appear possible to estimate phosphorus and molybdenum on one sample by dissolving in nitric acid, oxidising with permanganate and then separating the iron with caustic soda as usual. Of the filtrate, one fraction could be used for estimating molybdenum and one for the phosphorus.—Yours, etc.,

A. Allison.

J. J. Habershon & Sons, Limited,
Holmes Mills, Rotherham.
March 22, 1933.

[We sincerely thank Mr. Allison for placing these results at the disposal of the industry.]

Random Shots.

A recent article in this Journal, which described the large works of Czecho-Slovakia, threatened to cause intense interest in metallurgical centres. Waves of enthusiasm were converted into sound waves and amplified as lips smacked round and about furnaces and cantines. With what seemed like an aiding and abetting by the printers, all copies of this Journal for that week did actually open most easily at a page the first sub-title on which was

Pilsen.

Reading on, rather too quickly as was pointed out to me later, I seemed to gather that the largest Soda Works in the world were in Pilsen. Was this a change from the Pilsen of the good old days, and had the brewing of bottled joy received a check? Oh, Slovakia! Whither hast thou hopped?

Then I read that the Soda Works were the greatest engineering works in that Re-public.

I gave it up and went to sleep again.

* * *

The same issue speaks of the "Situation in Germany in 1932." And not a mention of Munich! What do we find instead? In place of those famous arguments, finished with the help of emptied bottles, we read the sub-title

"A Price-Cutting Orgy."

Bah! Give me the days when men were MEN, and Central Europe made money by consuming its liquid assets.

* * *

However, it's a poor wheel that has no turning, and we read on another page of the self-same issue: "Rust Prevention with Lanoline." My mother always uses rose water for ironing, so I was glad to learn the views of the National Physical Laboratory on other metallurgical uses for cosmetics. We read that unprotected steels (like unprotected ladies) rust in the atmosphere of Hereford in six months; but that if lanoline (I presume it may be coloured rouge, brunette or kiss-proof) is diligently used, then, like or unlike the ladies, steel will remain unaffected.

* * *

And speaking of supplies, we were told at a recent business dinner in Manchester (yes, my dear, they are always business dinners in Manchester) of the founder, who shall be nameless, who on announcing to his best girl that he was going to Paris (yes, my dear, you guessed rightly, on business), was told to get the latest fashionable tint of lip-stick for her at a certain Paris shop. A few days later, after having duly explained to the shop assistant the tint he had noticed on a lovely Parisienne's lips at Maxim's, the assistant asked him: "We have three qualities in that tint; which would Monsieur prefer? Our friend—whose name you all think you know—answered: "Well, now, what do you imagine? It's I who have to eat it!"

* * *

Whilst the Editor is away—by-the-bye, I don't know if anyone has told you, but in our office, when the Editor is away, that has to count as part of our summer holiday. We have never been told why; it has successfully been left to our imagination. Well, as I was about to say, whilst the Editor is taking our holiday, I have decided to bring the Journal more up to date. My first idea is to eclipse those catchy paragraphs so favoured by our smaller brethren, they of the Dailies, after this style:—

Don't July About It!

See what august has to say about it, page 123.
If you disagree, don't sling mud at him; try sand slinging. All about it on page 300.
If he is refractory, ape the wise and consult gibbons. All particulars on page 345.
If he is piggish, you consett him a better example. Details on page 456.

Marksman.

Héroult Electric Furnaces at the Dagenham Works of the Ford Motor Company, Limited.

One of the most striking features of the new Ford works at Dagenham is the fact that they contain all the necessary plant for the manufacture of iron castings for motor-engine cylinders. This consists of a blast furnace, a 600-ton and two 150-ton mixers and two 15-ton electric furnaces for refining the metal from the mixers. Brief particulars of this installation were given in our issue of September 16, 1932, but in view of the unusual nature of the arrangement, supplementary details are given.

The iron is conveyed from the blast furnace to the hot-metal shop in ladles having a capacity of 75 tons. The hot-metal shop runs alongside the foundry, but is quite apart from it. The mixers are arranged in tandem. The metal from the mixers is tapped into 25-ton ladles, which are mounted on bogie carriages and travel an elevated track which extends the full length of the shop. The metal is discharged, by tilting, direct into the electric furnaces, where it is refined.

The furnaces are of the E.F.C.O.-Héroult 3-phase type with three top electrodes, each of 14 in. dia. The electrode holders are of the tubular conductor type, and are connected to the transformers by heavy flexible copper cables, which can be seen in our illustration (Fig. 4). These cables, of which there are 19 for each phase, are each of 1 sq. in. cross section.

The launder at the back of the furnace through which the molten metal is charged can be seen in the near view of a furnace shown in Fig. 2. The furnaces are trunnion tilted on an axis passing almost through the spout of the furnace; there is practically no movement of the spout during pouring. Overhead girders, on the flanges of which carriages run, are so arranged that small ladles may be filled from the electric furnace and then quickly transported to any part of the foundry with minimum effort. A steel structure is arranged at the back of the furnace, carrying hoists which raise each furnace by nuts and screws.

Our illustration (Fig. 3) shows the two furnaces with tilting structure viewed from the

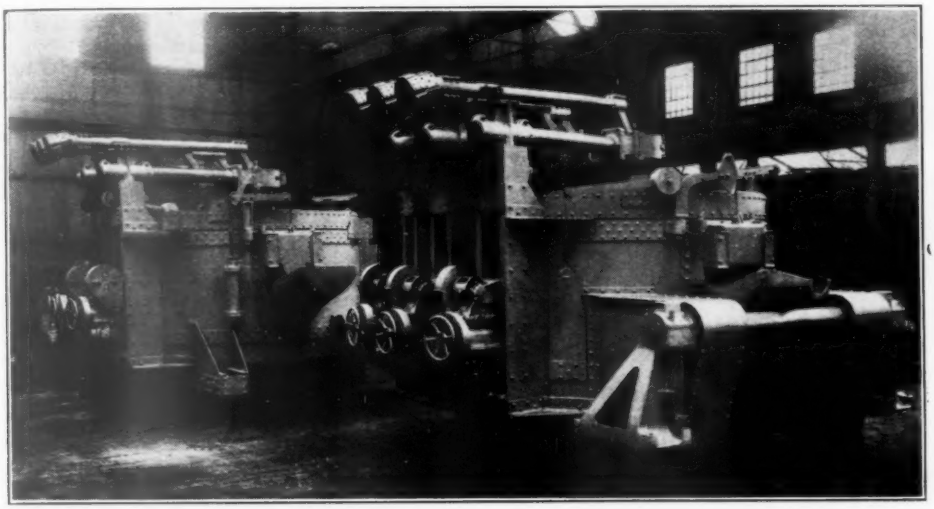

Fig. 1.—The Two E.F.C.O.-Héroult Electric Furnaces in the Works of the Builders; Edgar Allen & Company, Limited, of Sheffield.

Principal Contractors.

Electric Furnace Company, Limited, London.
E.F.C.O.-Héroult Electric Furnace Installation.

Sub-Contractors:

E. Allen & Company, Limited, Sheffield.
Electric furnaces.

A.S.E.A. Limited, Walthamstow.
Transformers and reactors.

Ferguson & Pailin Company, Limited.
Switchgear.

Watford Electric Company, Limited, London.
Automatic regulators.

Ashmore, Benson, Pease & Company, Limited, Stockton.
Pig-iron mixers and hot-metal ladles.

Davy Bros., Limited, Sheffield.
Hot-metal cranes.

British Thomson-Houston Company, Limited, Rugby
Diesel-engine locomotives.

Newton Chambers & Company, Limited, Sheffield.
25-Ton bogie-mounted ladles.

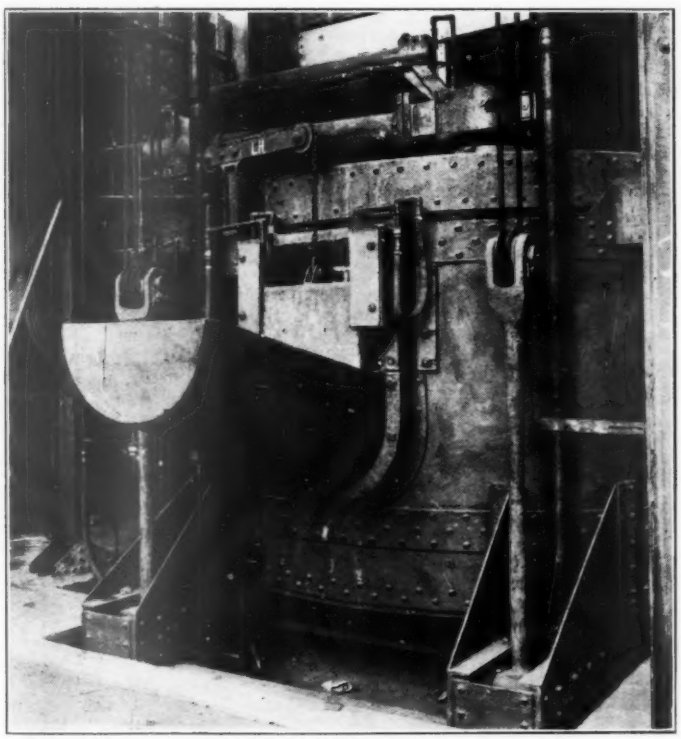

Fig. 2.—View of 5,000 k.v.a. Héroult Electric Furnace showing Charging Launder for Liquid Metal.

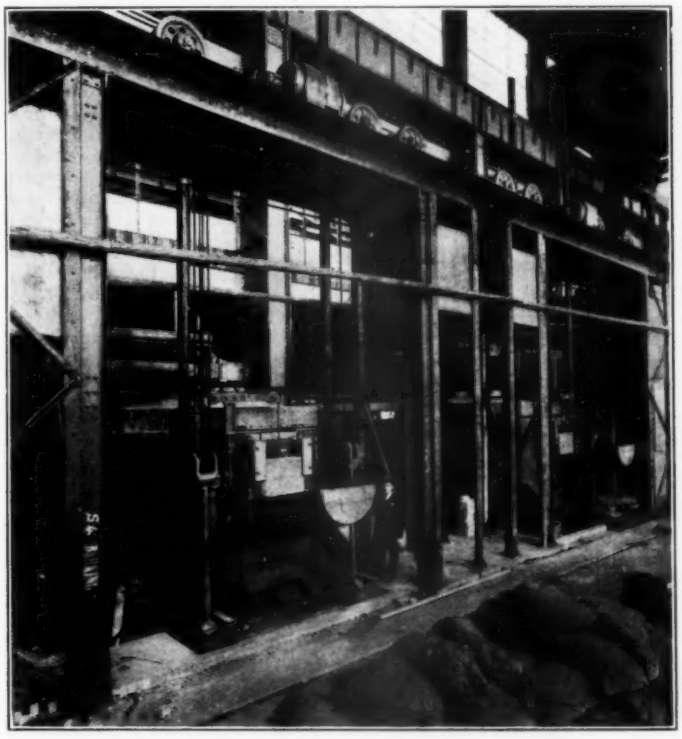

Fig. 3.—View of the Two Furnaces from Charging Side, showing Tilting Structure.

rear or charging side. A 35-h.p. motor, controlled from the operating platform is connected through suitable reduction gearing to the tilting screws, and limit switches are provided to prevent over-running in either direction of tilting. The weight of the furnace is partially counterbalanced by means of boxes containing 30 tons of steel scrap as an aid to teeming. Each furnace is equipped with a 5,000-k.v.a. 3-phase water-cooled transformer and a 940-k.v.a. reactor.

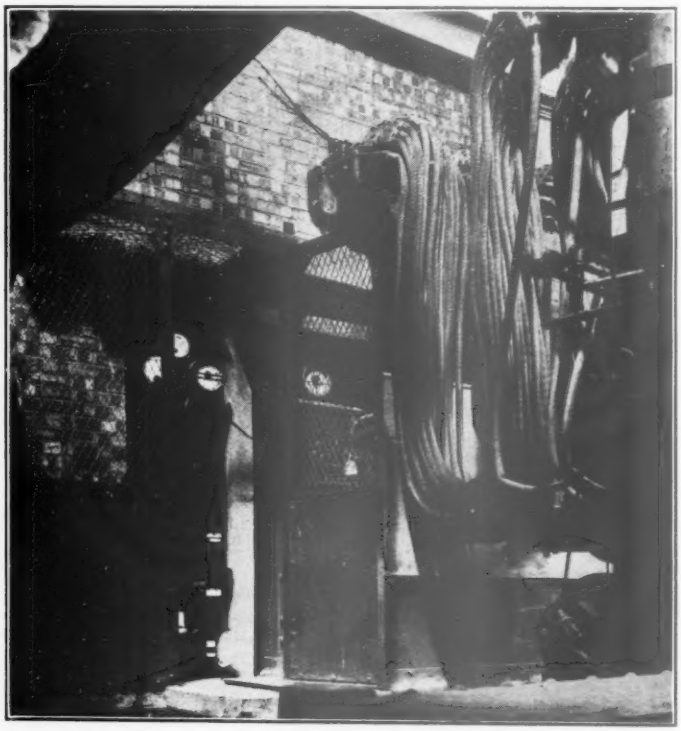

Fig. 4.—View of Connections between Transformers.

The 11,000-volt transformer primary windings are tapped to give a range of secondary voltages from 225 to 150, and the reactor has tappings at one-third and two-thirds winding. Off-load tap-changing gear is provided with the necessary interlocks, and all switching operations are controlled from a panel arranged on the left of the operating platform. During actual operation of the furnace, automatic regulators maintain the load on the furnace at any predetermined value down to 20 per cent. full load. The adjustment of the electrodes during operation is controlled individually through rope-hoisting gear driven by a 3-h.p. motor. The equipment described is the largest yet built in Europe for this class of work and embodies all the most modern improvements for the efficient production of high-quality cast iron.

The Follsain Process.

Something of a surprise was awaiting us when we recently visited the works of the Wycliffe Foundry Company, Lutterworth. We anticipated that the reason for our visit was to inspect the Sesci furnace, or perhaps to describe some new short-anneal process. Instead we were introduced to the Follsain process, which, briefly stated, consists in packing ferrous material with a mixture of aluminium, chrome oxide and a catalyst in a metallic container and submitting the whole to a temperature of about 1,000 deg. C. for 3 or 4 hrs. An alumino-thermic reaction takes place which results in communicating to the objects treated a fairly lightly adhering skin of probably alumina, beneath which is a skin of metallic aluminium, and finally the metallic object has been cemented with chromium metal. This process is covered by British patent specification numbers 337,562 and 337,635 of 1930. The process has for its immediate object the production of heat, rust and acid-resisting material, using cheap steel or cast iron as a basis. Now it is obvious that the first test a malleable foundry would impose would be upon their own annealing irons and Figs. 1 and 2 show results obtained. The left-hand illustration in each case shows a box which has been treated by the Follsain process and had at the time of our visit been submitted to 1,000 deg. C. for 630 hrs., whilst the one on the right is an untreated box which has undergone but 270 hrs. This actual annealing box withstood a temperature of between 1,000 and 1,100 deg. C. for 1,200 hrs., while the untreated box eventually oxidised and collapsed after 340 hrs. We have before us a report by a firm of consulting engineers of international note and unquestionable reliability which states that as a result of their experiments with tubes "the final results show that one of the best known heat and oxidation resisting metal tubes stood heating for 135 hrs., another 230 hrs., and the Follsain tubes 406 hrs."

It can well be imagined that this process is novel and gives all kinds of metallurgical curiosities. For instance, ordinary cast iron when treated by the Follsain process made a perfectly good turning tool indicating extreme hardness; two-inch lengths of treated mild-steel tubing we saw pressed vertically into ⅝-in. cakes without destroying the surface casing, indicating extreme softness; and finally white-iron malleable test-pieces after the Follsain treatment gave tensile and elongation tests equal, if not superior, to those malleablised in the normal method.

It can definitely be stated that for straight treatment to withstand high-temperature conditions the process is thoroughly commercial, and the Wycliffe Foundry are now experimenting and finding out all sorts of other interesting metallurgical results. They have such confidence in the process that they were installing at the time of our visit a Gibbons Dressler continuous furnace for the economic and commercial exploitation of the process. Moreover, new buildings are being erected to house the new department. We presume that the method of carrying out the business will be for firms to send along their own manufactures to be treated by the process.

Publication Received.

City of Birmingham Official Handbook, 1933, compiled and edited by W. S. Body, and published by the City of Birmingham Information Bureau.

We first saw this publication about 1928, and have watched its growth and appreciated its increasing usefulness year by year. By its side we have a similar publication emanating from a large foreign city, and the difference is striking. The foreign one is frankly written for the tourist, whilst Birmingham's effort is designed to interest the business community. If we have interpreted its import correctly we can next say that the book has well accomplished its task. Birmingham must, indeed, be prosperous to continue this annual publication, when most cities are curtailing this type of expenditure.

Fig. 1.—Annealing Boxes, the left of which has been Treated and done Greater Service at High Temperature than the Untreated Box.

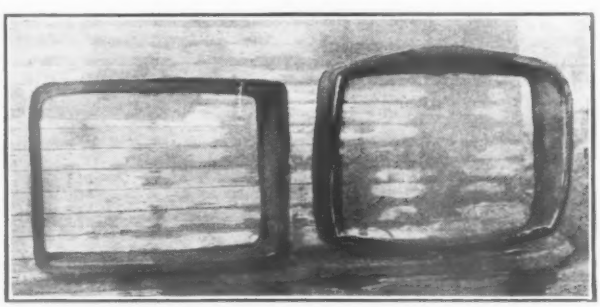

Fig. 2.—Showing the Absence of Bellying in the Treated Box at the left.

Some Brass Foundry Problems.*

By F. Dunleavy.

The job shown in Fig. 1 was set out to be made and cast on its end exactly as it would be made in a foundry possessing modern lifting equipment, which this one did not. The core, which was not simple, was strickled up in loam. It is approximately 3 ft. by 2 ft. and its bulk constitutes a problem. For the making of this core, two grids had to be fastened on to the barrel—one at each end—so that it would carry its load when turned over. The barrel at one end was made the length of the bottom print. It was strickled up in the usual way, each end being well sprigged, and by the time the core was finished it weighed several hundredweights.

In small shops, weight must be spread out, and probably this core was made in the wrong way altogether. It would have been preferable to have made one half-corebox. Moreover it would have been cheaper and easier to have started with a flat board with the recess pieces attached and provided with a pulley rim. Three or four various sized pulley rims ought to be kept in small foundries together with a flat-machined plate.

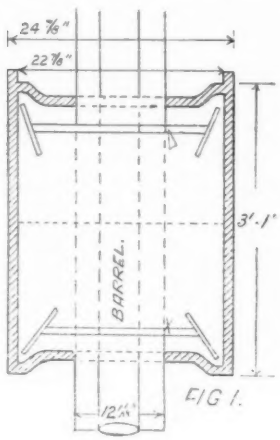

FIG 1.

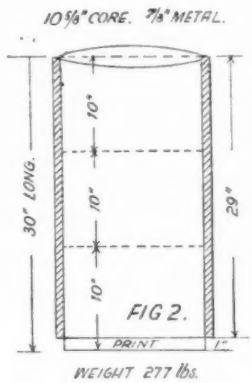

FIG 2.

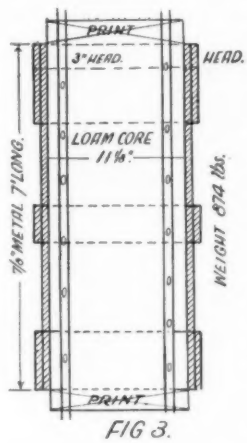

FIG 3.

Starting with the rim, the depth of which is 4 or 5 in. deep; if it is too shallow, it can be drawn up, and if it is too deep the pieces can be raised inside the rim. Now if two are to be made, placing one on the top of the other, together with two cores, 12⅛-in. dia., it makes the core complete. The end cores can be made to sit into the body core by fastening a print to the board. Another problem associated with small foundries is that of their melting capacity. In one case, for instance, the furnaces are of the usual pit-fired type, with a total capacity of roughly 8½ cwts. There are seven fires, comprising one for a 200-lb. crucible, two for 150-lb. crucible, two for 120-lb. crucible, and two for 100-lb. crucible; thus the capacity was at least 4 cwts. short for casting the job. The only available method was to use a 250-lb. pot with a 200-lb. fire, and so on down the scale. Even then, the management found themselves short of over 1 cwt. of metal. The difficulty was overcome by using a higher temperature than normal to melt suitable ingots and scrap placed at the bottom of the ladle. Fig. 2 shows a small liner which was urgently required, made from a block pattern forming the outside of the mould, with a print 1 in. deep on one end. This print is bedded into the bottom part, where a joint is made. The runner peg is set into position and rammed up halfway, where a second joint is made, and the job is rammed up to the top. A flat top only is required, having a tube over the runner peg for feeding purposes. This down runner must be opened out from 1¼-in. to 2½-in. dia. These figures are naturally variable, according to the section of the casting.

The sand used is the ordinary Mansfield red sand, and the mould is wet-blacked and stove dried. It was first thought to make the core to form the inside of the casting in loam, the board for which had been sent in with the pattern, but time and cost precluded this; thus the pulley-rim method was again utilised, and three of these, 10 in. deep, were rammed up on a machined plate with a 3-in. peg in the centre for the vent. They were strickled off level at the top of the rim, thus making two level joints, which is an advantage, because these three cores are placed one on top of the other, and, providing they give good contact with the top core and the top part, this method can be a great success, both as to cost and in distributing the weight. It enables one man to handle the core in place of the usual two or three.

Fig. 3 shows a larger type of liner, usually cast horizontally. Its core is made in loam on a core barrel. A full wooden pattern being supplied, it is bedded in one half of the box. A joint is made and the top half of the box is put on; it is rammed up; the box is divided; the pattern drawn; the mould repaired where necessary; the mould is wet blacked and put in the stove to dry over night. The following morning the mould is removed from the stove and allowed to cool a little, after which the core is placed into position and the top box is put on, ensuring that there is a good touch all round the mould, because if the metal runs out from this joint, there is little hope of stopping it up. The completed mould is lifted on end and lowered into a pit for casting. The core is kept in position by placing a spike through a hole in the core barrel, and wedged to ensure that there can be no slipping. It would be quite easy to make this job on end if the bottom and middle rings had been loose or bedded to when ramming up the mould. This would have eliminated a joint the whole length of the mould, as is shown in Fig. 3.

The reason for detailing this job is that it typified the kind of job which should not be tackled in small non-ferrous foundries unless they have a pit deep enough to enable them to cast it on its end. The foundry in question has not this advantage, so the mould was tilted up as high as conveniently possible and cast. There are, however, one or two very real dangers with this method; one is that of the drawn place at the joint of the two different sections, with flat places along the top of the casting. A second is that of the lapping of the metal due to presence of a film of oxide, and leaving to all appearances two distinct layers of metal.

Covering a Hydraulic Ram Pump Shaft.

Fig. 4 shows a burning-on job. Actually, this is only a coating proposition, because that is all that happens, or could be expected to happen, bearing in mind the different melting points of iron and brass. The mould is made from the ram itself, which is covered by ½-in. strips of wood to give the necessary metal thickness. It is bedded into the bottom part with the ends of the ram resting on the bearer X at the end, this maintains the ram rigid during the casting process, and without it the shaft would not keep its position. The top part is now rammed up, incorporating a fairly large-sections down runner, and removed, after which a runner is cut the whole length of the casting about 1 in. from the mould face. A large quantity of shallow ingates are cut; the pattern is drawn and mould repaired where required.

Then a pricker is driven through the top part about every 1¼ in.; although the length of the ram determines the distance between the whistlers, and, actually, the shorter the ram the closer will be the whistlers. When this is completed, the wooden strips are taken off and the shaft is cleaned thoroughly. There must be no grease or dirt left on or blow-holes will result. The ram is now heated up to 500 deg. C. Overheating increases the evolution of mould gas, which is undesirable. The shaft is placed into the mould resting on the bearer at the end X, the top part is placed on, weighted and cast immediately. Under these conditions a sound casting can be almost assured.

On one occasion a casting of this type was run with three ingates and two risers (Fig. 5). As a result, it was covered with blow-holes all along the top. A second try (Fig. 6) was made by casting on its end, with two runners and one riser, and this also was a waster. Actually, it was worse than the first one. A third attempt was successful.

Another method (Fig. 7) used for these jobs is to cast a ½-in. shell, and after being bored it is shrunk on to the ram. Yet another is to cast them on end with a blank end on the casting, but this is probably bad practice, because the core may move and come through at the side. This could be overcome if the barrel was arranged as shown in Fig. 7.

Another alternative method, but much more costly, is that shown by Fig. 8. It entails a special pattern and corebox, and thus depends upon quantity. These jobs, however, are usually "one-off," but this method would certainly eliminate the trouble caused by the core moving from its position and also the necessity for the plug shown in Fig. 7.

Bearings.

Fig. 9 shows a group of bearings of the type that leave their own core and are always cast dry-sand. The main considerations in the production of these are venting, arrangement of the runners, the method of feeding them and the casting temperature. It is advisable, when ramming the inside, to put ashes behind the face of sand and to avoid ramming too hard near the face. When the side is rammed up, it becomes the bottom part, and it is advisable to push both tube and vent wire down to the ashes, because it is risky to trust to the permeability of the sand, for the escape of the gases generated during casting.

The more common type of bearings are those with a flange at each end. Wooden patterns are generally supplied with a print on each end, approximately 1 in. long, with the same length of print on the bottom of the pattern. The bottom print enables the moulder to make the mould up flush with the core, and no risk is taken of the metal finding its way underneath to the vents. The end prints are banked up and

* Extracted from a Paper read before the Lancashire Section of the Institute of British Foundrymen, Mr. Ellis Flower presiding.

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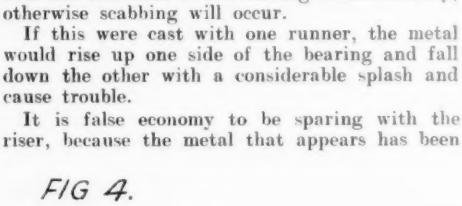
strengthened with irons or gaggers so that they will keep their position when the top part and the pattern are taken off. The advantage of this cored bearing to the foundry is that it enables them to be cast with merely skin-drying the top part.

Bearings should always be moulded with the casting in the top part, that is to say, the machined face down. The runners must be placed in such manner that the metal will rise over the two sides of the bearing simultaneously, otherwise scabbing will occur.

If this were cast with one runner, the metal would rise up one side of the bearing and fall down the other with a considerable splash and cause trouble.

It is false economy to be sparing with the riser, because the metal that appears has been

FIG 4.



forced through the mould and is naturally the coldest metal, and if the risers are not of sufficient volume the casting will be drawn between the body and the flange, at the junction of the two different sections. This is caused by the riser solidifying first, thus the casting must always solidify before the riser. The best method would be to have two additional pots

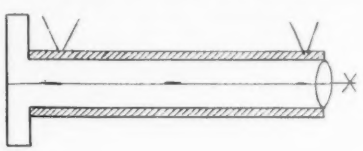
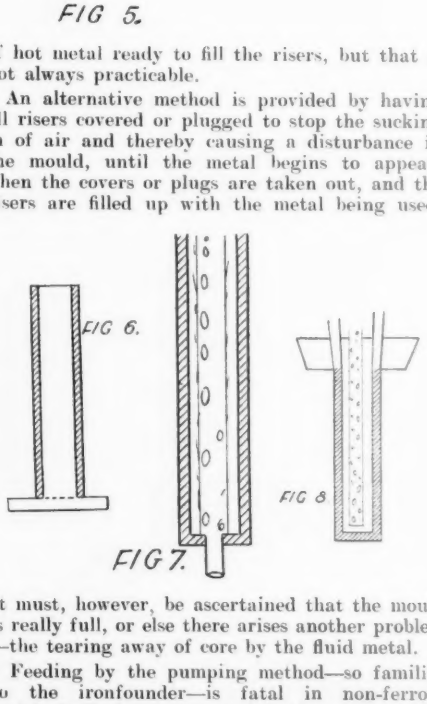


FIG 5.

of hot metal ready to fill the risers, but that is not always practicable.

An alternative method is provided by having all risers covered or plugged to stop the sucking in of air and thereby causing a disturbance in the mould, until the metal begins to appear. Then the covers or plugs are taken out, and the risers are filled up with the metal being used.



It must, however, be ascertained that the mould is really full, or else there arises another problem—the tearing away of core by the fluid metal.

Feeding by the pumping method—so familiar to the ironfounder—is fatal in non-ferrous metals.* It is at the period when the molten mass is passing from the fluid to the plastic stage that a great deal of damage is done. Even whilst the molten mass is still fluid, it begins to pump back through the runners in a see-saw fashion, which is objectionable in non-ferrous practice.

Most of these bronzes have a strong tendency to liquate and it is difficult to cast such castings of heavy section without this change being noticeable. Gunmetal, for example, will be tin stained or covered with white spots if the casting is not cooled very rapidly. On the other hand, if the casting is poured too cold, it is certain to be drawn between the flange and body, and in all probability, if such a casting is broken up, it will be found to be composed of two distinct layers of metal.

This condition will be found about half-way up the bearing, due possibly to the metal being too pasty to break up the film of oxide at the point where the metal falls away to form the top of the casting.

Small Bearings Approx. 80-lb. Weight.

Fig. 10 shows a group of small bearings that can be cast successfully without risers. It is felt that to place a riser on them is a mistake, and that view is borne out by results, providing that the casting is of a fairly uniform section. Because in many such instances the riser will "pull" the casting instead of the casting "pulling" the riser, with the result that, at the junction of the flange and the body, a large crack will appear and the casting be ruined. Fig. 10 shows the method of running smaller bearings by means of a low runner and the whistlers—one on each flange. Good results are

Fig. 9.—Group of Bearings leaving their own Core.

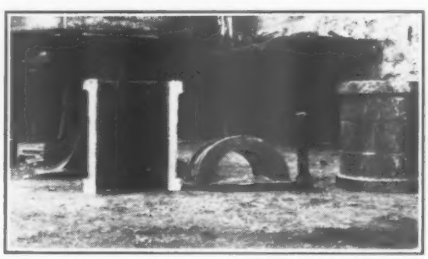


Fig. 10.—A Group of Small Bearings which can be Cast without Risers.

assured if they are cast at a reasonable pouring temperature. All these smaller bearings are cast in green sand.

If such castings are poured at 1,100 deg. C. they are usually to be relied upon. If they are cast at a much higher temperature they will be open-grained and the castings probably wasters. Moreover, if these are cast at a lower temperature, say, 1,080 deg. C., it will probably be found that on machining a number of small clean subcutaneous holes will appear. These are air traps, and caused by "dull" metal, incapable of driving the air from the mould. If such castings be broken up, it would be found that, instead of it being drawn at the flange as would be the case if a riser was used, a crack would appear on each side, extending almost the whole length of the casting. These cracks often appear just before the finishing cut is taken.

Aluminium Alloys.

Much of the confusion as to the casting of these alloys has been, and is still, caused by neglecting the following first principles:—Sand must be rammed lightly over the faces; sand must be used on the "dry" side and well vented; the greatest care must be taken in placing the runners, risers and chills; the construction of all cores and the pouring temperature. Fig. 11 shows an aluminium ring measuring large 2 ft. 6 in. outside dia., 5 in. wide and 4 in. deep.

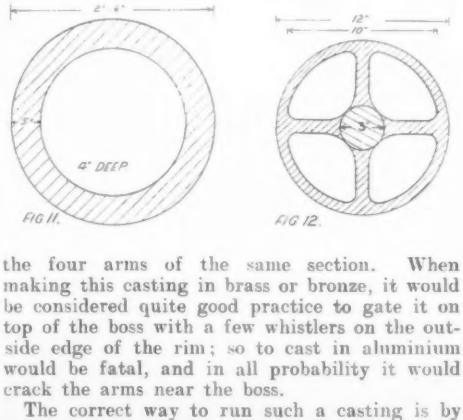
The difficulty with such jobs is that they are bedded into a bottom paste box, and the outside of the casting is chilled all the way round with cast-iron chills 3 in. thick, and unless the moulder is very careful the bottom face of the mould will be hard. The only solution of this problem is to vent it with an $\frac{1}{8}$-in. vent wire, covering them up lightly over the face, making sure that the vents have an outlet at the bottom of the box. If this venting be neglected, it will probably be found that the casting has a worm-eaten appearance on the bottom face, with the result that the casting will be a waster. The explanation put forward is the quantity of air that is held between the particles of sand throughout the mould and when this air becomes heated by the metal in the mould it expands, and must be allowed to escape easily and rapidly.

The heated air will tend to rise, so that all that occurs over the top of the casting will naturally escape through the top part, but that below the casting will rise through the molten metal unless an easier exit is provided. Venting after the pattern has been withdrawn from the mould can only be done when the casting has to be machined on a particular face, and it is common knowledge that every toolmark will show on the resultant casting. Therefore such moulds must be tooled as little as possible.

In view of the lightness of aluminium and its habit of filming over with a skin of oxide it will be understood that it has less ability than other metals to drive the air from the mould and completely to fill all the sharp corners. This means that the mould must be porous, light-rammed and vented.

The ramming really depends upon the nature of the job; castings of large section will, of course, require more ramming. If the mould will hold together, that is all that is required, because it will allow more time in stripping, with less fear of cracking. In placing the runners, they must be so placed, and of such a diameter, that the casting cools uniformly. The moulds must be cast quickly, but with as little disturbance as possible.

As an example, Fig. 12 shows an ordinary hand-wheel, 12-in. dia., with a centre boss 3-in. dia. and $1\frac{3}{4}$ in. deep on one side only. The outside rim is $\frac{3}{4}$-in. section and 1 in. wide, with



the four arms of the same section. When making this casting in brass or bronze, it would be considered quite good practice to gate it on top of the boss with a few whistlers on the outside edge of the rim; so to cast in aluminium would be fatal, and in all probability it would crack the arms near the boss.

The correct way to run such a casting is by spray runners along the outside rim with a riser on the centre boss. A characteristic of alumi-

(*Concluded on page* 232.)

* This is not universally true, as manganese bronze propellers are "pump-fed."—Editor.

"Bakelite" Bonded Grinding Wheels for Snagging.*

By C. A. Carlson.

In the manufacture of steel and metal products, the grinding wheel has become a very important factor. When finishing castings of all kinds, the gates, risers and fins are removed by grinding. An increasing number of different types of alloy steel are ground before finish rolling, to remove defects and ensure the highest quality of products. Forgings are ground to trim off burrs and fins, or to prepare for succeeding polishing operations.

The great variety of work, methods and machines presented problems which had to be solved by close co-operation between the grinding-wheel maker and the consumer. Great forward strides have been made, and one of the most important is probably the introduction of high-speed "Bakelite" bonded wheels.

Since their inception a few years ago, Norton "Bakelite" wheels have become one of the most popular grinding tools. With their advent, it became possible to procure grinding wheels which perform the work at a lower cost and with less

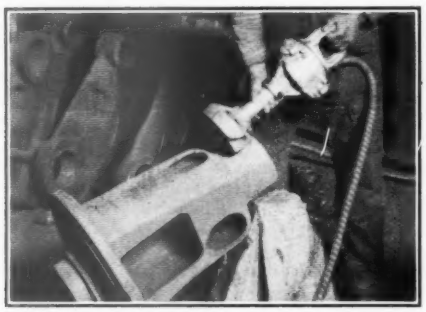


Fig. 1.—Air-operated Portable Machine for Snagging, equipped with "Bakelite" Bonded Grinding Wheel.

effort. The effect of removing material at a faster rate has been to raise the standards of workmanship, and "Bakelite" wheels have done much to give the industry neater-looking castings, automobile parts, and utensils, to which the public has become accustomed and now demands.

Early in the use of "Bakelite" as a bond it became evident that in order to take full advantage of the keener-cutting qualities and to protect the softer-bonded "Bakelite" wheels against excessive vibration, new machinery had to be designed. Existing machines designed to run at a maximum wheel speed of 6,000 surface ft. per min. usually were equipped with plain bearings and with wheel guards only strong enough to withstand wheel breakage at that speed. It was necessary to build machines with more substantial ball or roller bearings to carry the wheels at a speed of 9,000 surface ft. per min. and to design wheel guards which would protect the worker in case of wheel breakage. Machine builders are now making several types of high-speed snagging machines. High-speed grinders operating with "Bakelite" wheels are now used throughout the country for many kinds of work.

Swing Frame Grinding.

One of the most important machines is the swing-frame grinder, which is used for grinding large and medium-size castings and for grinding out defects in ingots, blooms, and bars previous to finishing high-grade alloy steels. The swing-frame machines are made for different size wheels. For large work and where a good deal of material is to be removed, 24-in. machines are probably the most popular size. For smaller castings and for some billet grinding 20-in., 18-in. or 16-in. swing-frame machines are used. The advantage of the larger machines is their higher rate of production and economy. Smaller and lighter machines mounting smaller wheels can be handled with greater ease and are preferred when grinding in limited areas, as for example removing seams or cracks in billets.

Floor stands are made in many sizes. The most popular for production grinding are the 30-in. machines, but 24-in., 20-in. and 18-in. high-speed floor stands are also common. The kind of work done on these machines consists of all kinds of castings and forgings. The advantage of "Bakelite" bonded wheels over other types of wheels on floor stands is greatly increased production, smooth finish, and the ability of the wheels to cut fast with a very light grinding pressure. The cost of work is much lower than with harder-bonded slow-speed wheels.

High-speed portable grinders mounting 6-in. or 8-in. "Bakelite" wheels are used extensively for finishing intricate steel castings and large machine castings. Many of these hand grinders are also used for automobile body work, such as grinding the bead left by welding and similar operations When finishing and repairing large dies the portable grinder with "Bakelite" bonded wheels is a valuable tool. For inspection grinding to remove hair-line seams on high-grade steel bars before finish drawing or rolling, the portable grinders with high-speed wheels are used very successfully.

Norton "Bakelite" wheels are made either of "Alundum" abrasive or "Crystolon" abrasive, depending upon the type of material being ground.

Selection of Wheel.

Selection of the most economical snagging wheel for a job is essentially a case of striking the proper balance between wheel life and rate of cut. A wheel may be of such a grain and grade that it shows suitable rate of production but short life; or a wheel may be of a grain and grade that will give satisfactory life but a slow cutting rate. Striking the proper point between these extremes is the task of the grinding engineer. And this point is not a fixed one but varies with different foundries—depending upon the nature of their work, their production requirements and other factors.

Controlled structure is a Norton development that has proved of great help in selecting the best wheels for a job—wheels that give the proper balance between life and rate of cut. In Norton "Bakelite" wheels the amount of abrasive—the spacing of the grains—is accurately regulated. Just as grain size is graduated by steps from coarse to fine, just as grade is graduated in steps from "hard" to "soft," so structure is graduated by definite steps from "open spacing" to "close spacing" of the grains. Each structure, each graduation has a definite symbol so that it can be exactly specified, just as grain and grade are specified.

Grinding action can, therefore, be regulated more closely, can be varied by smaller increments than when only grain size and grade were varied. It is also possible to select more accurately just the proper wheel for each individual snagging job—the wheel that will give the most economical combination of rate of cut and length of life. The same features of controlled structure which make possible more accurate wheel selection, also make possible more accurate wheel duplication. When the proper grinding action for a job has been determined it can be more closely duplicated in succeeding wheels by controlled structure.

For rough grinding operations a wide range of grain sizes are used, from No. 10 the coarsest, to as fine as No. 46. The grades vary from N to as hard as S. Structures range from No. 2 (close spacing of the grains) to No. 9 (open-grain spacing).

Loss Prevention.

Practically all "Bakelite" wheels are made with large holes to prevent waste of abrasive material and to reduce wheel cost by utilising most of the wheel, leaving only a stub about two inches larger than the hole. To add strength and help to safeguard against breakage, strong welded steel rings are imbedded in the wheel near the hole.

A main requirement for good economy with "Bakelite"-bonded wheels is to maintain a speed between 9,000 to 7,500 surface ft. per min. At lower speeds the wheels wear faster and the rate of production is lowered.

When selecting "Bakelite"-bonded grinding wheels for the different operations, there are a few important points that must be observed. For steel with high-tensile strength "Alundum" abrasive is best suited. This includes steel castings, tool steels, alloy steel, heat resisting and stainless steels. "Crystolon" - "Bakelite"

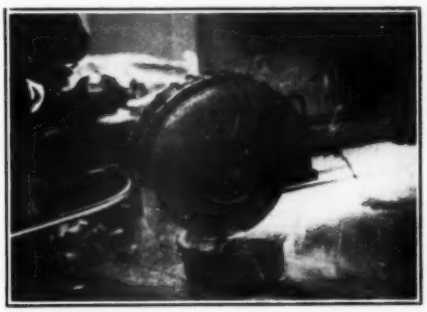


Fig. 2.—High-speed Snagging—Norton Swing-frame Machine and "Bakelite" Bonded Grinding Wheel.

wheels are superior for brass and bronze castings, certain operations on grey iron castings, and practically all natural and manufactured mineral material. The grain size, structure and grade of the wheels depend on the nature and severity of the grinding operation. With increased pressure per contact area, larger grains, harder grades and closer grain spacing (structure) are selected, but if for example the wheel grinds with the whole width of a three-inch face, it is advisable to use softer grades, finer grains and more open structure. Swing-frame machines usually require harder wheels than do floor stands, as more pressure is exerted through the leverage of the handle bars and the convenient position of the workman. When better finish is desired, finer wheels are used. When grinding steel sensitive to heat, cooler cutting, softer wheels with more open structure are more suitable.

Steel Foundry Practice.

Better to understand the use of "Bakelite" wheels, a trip through a typical steel foundry cleaning room will give a good illustration. When the castings come from the foundry, the gates and risers are cut off ¼ in. to ½ in. above the casting with an acetylene torch or power shears. The larger castings are taken to the 24-in. swing-frame machines, where 24-in. × 3-in. × 12-in. 14-Q4T-2 "Bakelite" wheels grind off the excess material on gates and risers as well as fins from parting lines, and also do any grinding to proper dimensions that might be necessary. The medium and small castings go to the floor stands, where 30-in. × 3-in. × 12-in. 14-Q2T-2

(*Concluded on page* 224.)

* Extracted from "Grits and Grinds." The Author is associated with the Sales Engineering Department of the Norton Company.

XUM

Outlook for Iron and Steel.

SIR WILLIAM LARKE'S REVIEW.

The present position and future prospects of the iron and steel industry were reviewed by Sir William J. Larke (Director, National Federation of Iron and Steel Manufacturers) in a lecture in Glasgow on Friday, March 17, to the West of Scotland Iron and Steel Institute.

Sir William stressed the need for international co-operation. He said that, owing to the fact that supplies were cut off from certain markets while the principal producing countries were engaged in the Great War, new industries were set up in countries which hitherto were not producers, but which possessed the natural resources of ore and coal. That was perhaps most notable in the Dominions of the British Empire. Further, very considerable developments had taken place on the Continent of Europe, where in France new works were set up during the war period when those within the war zone had to cease operations, and as a result of the Treaty of Versailles the devastated areas in France were made good under reparations, and the iron and steel works which had been destroyed wholly or partially were re-established, almost invariably on an improved and expanded basis. Again, by the transfer of the iron and steel works of Alsace-Lorraine, France had obtained an increased productive capacity of some 2,500,000 tons per annum. Germany, from whom this was transferred to France under the terms of the Peace Treaty, had since replaced within her borders the capacity which she thus lost not only in Alsace-Lorraine, but also in Silesia. In addition to that redistribution of ownership and increased capacity, there had grown up an entirely new system of tariff divisions and protective markets

Position in Great Britain.

Thus, there was the present position, in which some markets were reduced because they had begun production within their own area, and the remaining "free" markets were suffering from increased competition due to the fact that a large increased surplus capacity required to find an outlet in them. What was the position of their own industry in relation to national economy as affected by the world conditions? The numbers of insured workers in the British iron and steel industry to-day totalled nearly 300,000. Its export trade represented 7.77 per cent. of the total export trade of the country in value; and it had a capital of approximately £200,000,000 invested in it. It was unfortunately true that only 63 per cent. of the insured workers were at present employed, but that was to-day a much greater percentage than obtained in any other country with the exception of Belgium and Luxemburg. It was significant that in 1932, while the British industry increased its steel production by a fraction as compared with 1931, the production of the rest of the world declined by 28 per cent. in the same period. The United States declined by 50 per cent., Germany 32 per cent., France 29 per cent., Belgium 13 per cent., Luxemburg 3.5 per cent., while Britain's production advanced by 1 per cent. Relatively a satisfactory position—but only 45 per cent. of our total capacity was employed.

Potentialities of Improvement.

Speaking of the future, Sir William stated that the potentialities of an improvement in the iron and steel industries of the world were substantial to the extent that there was unquestionably a vast potential demand for the products of these industries, which there was some reason and evidence to believe exceeded the present world capacity to produce. Reference had frequently been made to the fact that the rate of consumption of iron and steel by the modern world had in recent years been actually decreasing, due to conditions entirely external to the industry. They were in effect not suffering from over-production, but from under-consumption. It might be argued that the iron and steel needs of the world were satisfied and that saturation point had been reached, but a very brief consideration of the tendencies of modern life and the developments that had taken place in the post-war period would show that the consumption of iron and steel per head of the population should be greater than in pre-war years.

Referring to technological advances, and in that respect he believed the British industry still led the world, Sir William stated that that in itself was not a solution to the modern problem. The immediate problem of the industry was economic, relating to distribution, rather than technological relating to production.

Book Review.

Handbuch der Spritzgusstecknik (The Pressure Die Casting of Metals), by L. Frommer. Published by Julius Springer, 23, Linkstrasse, Berlin, W.9. Price 66 RM.

The rapid development of die castings during the past few years has been a prominent feature of the non-ferrous section of the foundry industry. The simple type of plunger-operated die-casting machine for low-melting-point alloys and the gravity-die-casting machine have been augmented by a wide range of machines for the production of pressure die castings in a large number of alloys, including aluminium and light alloys, and more recently in the yellow alloys, such as brass. The literature on the subject, as in other rapidly-developing industries, has been mainly confined to scattered articles in technical journals. The appearance of a text-book on the subject of pressure die castings is, therefore, an important step in the establishment of the technology of the industry on a proper basis in the field of technical literature.

The author has dealt with the subject in a complete and detailed manner, intended to cover the requirements of the manufacturer of pressure die castings, the manufacturer of die-casting machines and the purchaser of die castings. Such a scope for a single volume is truly ambitious, but the author is to be congratulated on his endeavours. A full mathematical and practical consideration is given to the theory of flow of molten metals under pressure into a mould and the consequent requirements regarding nozzle design and disposition. The collection of the various mathematical formula into one chapter (at the end of the book) is a convenient method of dealing with what is often a stumbling block to the non-mathematical reader. A section is devoted to the design and construction of the mould dealing with the application of cores, the ejecting device, removal of air and materials used for making the mould. A detailed description of some thirteen moulds from actual practice is included in this section. A detailed account of the design of the casting machine includes both the piston plunger and the compressed-air type. The arrangement of the mould in the casting machine has also been given a careful consideration. A description of about 20 European and American machines is given, with full illustrations, and it is interesting to note that Polak, Eckert and Thieslack machines for brass pressure die castings are included. The chief feature of these machines is the use of a separate melting furnace and a cold-pressure chamber into which the molten alloy is poured before being injected into the mould. All three types are piston-plunger operated.

It is only to be expected that pressure die casting has a host of metallurgical problems, both as regards the behaviour of liquid metal during the filling of the mould and on solidification and subsequent cooling, as well as from the point of view of the physical properties of the metals used for die castings. The author gives consideration to both aspects and covers fully the various metals in use, including tin-base, lead-base and zinc-base alloys of low-melting temperatures; the light alloys of aluminium and magnesium and the copper alloys, with correspondingly higher-melting temperatures. The influence of casting technique on the quality of the castings produced is well emphasised and as the pressure die caster, like other foundrymen, is troubled with blow-holes, draws, hard spots, porosity and many other defects the author has dealt with these matters comprehensively.

It is impossible, in the course of a short review, to deal with the wealth of detail and careful consideration which has gone into the compilation of this book, which must surely be the standard work of reference for years to come. The book runs to nearly 700 pages, and includes 244 figures and 6 folding diagrams.

F. K. N.

"Bakelite" Bonded Grinding Wheels for Snagging.

(*Concluded from page* 223.)

or 16-Q2T-2 "Bakelite" wheels grind the castings to desired dimensions and grade of finish. As a final operation on a number of more intricate castings, portable grinders with 6-in. × 1-in. × ⅝-in. or 8-in. × 1-in. × ⅝-in. 16-Q4T-3A or 20-Q4T-3A "Bakelite" are used to clean out corners and places where it is impossible to use the larger wheels. Portable grinders with cup wheels are also used to give some castings a more polished appearance.

The Norton high-speed "Bakelite" wheels have been adopted in many foundries on account of the lower grinding costs obtained month after month in exhaustive tests. The cost of grinding with "Bakelite" wheels in different foundries is nearly the same if figured on basis of material removed, but the cost per ton varies considerably according to the type of castings ground.

Swing-frame machines for 16-in. to 24-in. dia. wheels are used for grinding ingots and castings; the larger wheels, for work requiring much grinding or with large flat surfaces. Typical wheel specifications are 24-in. × 3-in. × 12-in. 14-Q4T-3A and 12-Q4T-3A. The smaller wheels are used for lighter work, and especially when the grinding is to be done in spots. As the corners are used more on the smaller, thinner wheels, they are made in harder grades, typical specifications being 12/3-R3T-3A and 14-R4T-2 "Bakelite."

Speed Limits.

There has been some speculation as to whether still higher rates of production and lower costs could be obtained if "Bakelite" wheels were run at speeds higher than 9,000 surface ft. per min. It is true that thin "Bakelite"-bonded wheels are run at much higher speeds for cutting off metal, but they are used at very near their ultimate strength and are almost completely enclosed to afford the workmen ample protection. Most snagging operations, however, require a generous exposure of the wheel, and the methods of handling the work are none too gentle. The recommended speeds allow for a safety factor of nearly 4 to 1. An increase in speed of 30 per cent. changes the safety factor to 2 to 1, which is too small a margin. Also, many tests on present machines have failed to disclose any definite benefit from the higher speeds.

The Norton company is constantly engaged in improving "Bakelite"-bonded wheels and in finding new fields for their use. The introduction of controlled structure wheels was an important step. It assures uniformity and makes it possible to produce the type of wheels best suited to the various grinding operations. Results obtained with the newer kinds of "Bakelite" wheels indicate not only improvement over older types, but also an increase of their usefulness for work formerly done by other wheels or methods.

New Solvent for Boiler Scale.—According to Technische Blätter of the Deutsche Bergwerks Zeitung, a new substance for removing boiler scale, termed "Lithophob," has been evolved in Germany, which removes scale by mechanical action. The preparation is said to penetrate the scale until it reaches the metal under-surface, and then breaks up the scale into flakes. The material does not damage the boiler interior or other fittings; it is composed of inorganic substances with a graphite base. The amount used is determined solely by the area of surface to be treated and not according to the hardness of the water or the evaporation of the boiler. Treatment is only necessary once every four to six weeks, and a few applications considerably diminish the tendency for scale formation. Practical tests with this material indicate a marked increase in boiler efficiency and a saving in fuel costs.

Recent Research in the Iron Foundry.*

By S. E. Dawson, F.I.C., A.M.C.Tech., M.Inst.Met.

Introduction.

It has been suggested by the author that much benefit and interest might be brought to members of all branches of the Institute by a review, in the form of an annual lecture, of the principal research work which has been or is being carried out for the advancement of foundry knowledge, and in some measure the present Paper is on these lines, though no attempt has been made to cover more than a few examples and their applications coupled with a general review of progress based on plant, processes, sand and metal.

No branch of the engineering industry has been subjected to so much adverse criticism as the foundry, and this may be due in part to its being the starting point of much of the raw material used in the various shops, and therefore beyond which no subsequent faults or blame can be referred. The engineer judges the foundry largely by the quality of its product, but the foundryman has many factors to consider in attaining a desired standard of excellence, and, mainly due to the efforts and improvements in the modern foundry, that standard has never been so high and rigid as it is to-day.

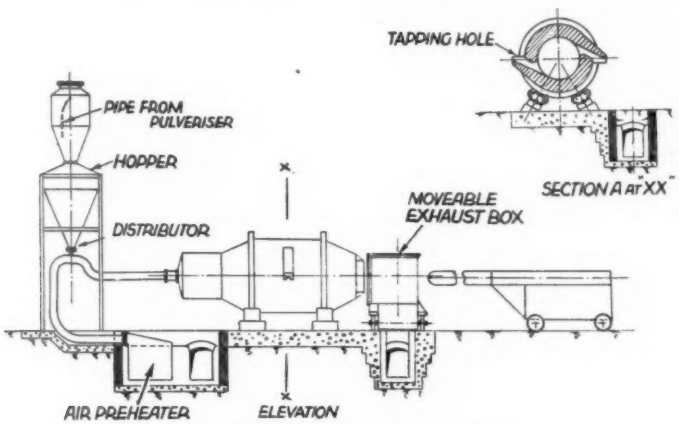


Fig. 1.—Lay-out of the Sesci Furnace.

In the past, cast iron was not regarded with great favour by the engineer owing fundamentally to its limitations in strength, elongation and homogeneity, and to some extent to its method of production in a shaft furnace which subconsciously brought to mind the cruder pig-iron product of the blast furnace. These factors were more or less accepted in the early days of cast-iron manufacture, but such great strides have recently been made both in regard to its properties and methods of production that its status has been raised to one of paramount importance in almost all industrial designs and duties.

Indeed the story of the progress of the development of cast iron during the last 10 and 20 years if told in full would be as entrancing as that of any of the great engineering achievements of modern times. Adequate evaluation or payment is not yet given for the improved results attained, but in many directions there is evidence that the greater appreciation of the high strength and special duty irons is bringing its just reward.

Many of the improvements in the modern foundry are largely due to economic factors, and in the sequence of progress to this end investigation was first directed to the improvement of the material itself, and so successful has this been that not only has cast iron been brought towards the region of steel so far as mechanical strength is concerned, but its composition has been so altered, and added to that its special applications in other fields of usefulness have been widely increased, and the engineer may well look forward to still further improvements in the many directions in which the investigations of the metallurgist are proceeding. Indeed, the structural qualities of cast iron have been so improved and extended that all the ferrous metals—cast iron, malleable, steel, etc.—may now almost be incorporated under one classification.

The intensive investigations to which cast iron has been subjected in recent years have been responsible for the isolation of the many forms in which it is now possible to produce this complicated and many-phased ferrous alloy or conglomerate structure. Most of the many forms of which metallurgists are familiar in steel obtained by suitable heat-treatment are now capable of being produced in cast iron, though usually in a multiplex form. Such conditions or structures giving accordingly as many variable properties are brought about by composition, conditions of melting, subsequent heat-treatment of the casting, innoculation of the molten metal, and after-treatment of the casting by gases and alloy additions.

Composition.

The variability due to composition is largely effected through the carbon, and here it might be well to see how large a part the so-called impurities in cast iron are capable of playing.

Table I.—*Rational Analysis of Cast Iron.*

Ultimate Analysis per cent.		*Rational Analysis per cent.*
Graphite carbon 2.70	giving	2.7 graphite
Combined carbon 0.75	,,	11.0 carbide of iron.
Silicon 2.33	,,	7.0 silicide of iron.
Manganese 0.60	,,	0.54 carbide of manganese.
Phosphorus 1.10	,,	7.1 phosphide of iron.
Sulphur 0.08	,,	0.22 sulphide of manganese
Total 7.56		28.56

It will be seen from Table I that what might appear a relatively small amount of an element present, as shown by the "ultimate" analysis, may have a very profound influence as a compound having vastly different properties to the iron or ferrite with which it is associated. More important still, perhaps, is the effect of the melting and cooling conditions on the form or structure of the iron and its constituents, and such conditions, in conjunction with the general composition, control the amounts, form and disposition of the ferrite, cementite, pearlite, graphite, etc., which in turn determine the suitabililty of the iron for a specific purpose or duty. In appreciating such improvements in the material structure itself the advancements achieved in the more physical aspects, such as contour and appearance, as well as the means of melting, cannot be ignored.

Sand.

For the physical aspects of castings, industry is indebted to the moulding machine, an early example of the engineer's skill applied directly to moulding, and to the sand which is only now receiving the full investigation it deserves, having in mind the important part it plays, not only in producing the much-desired "skin" to give a pleasing appearance, but in providing a moulding medium embodying correct venting, stability and refractoriness so necessary to the production of sound, clean and true-to-pattern castings. Such research has resulted in a thorough knowledge of the main deposits suitable for foundry work in Great Britain and the introduction of tests and testing appliances to cover the most exacting requirements of the industry.

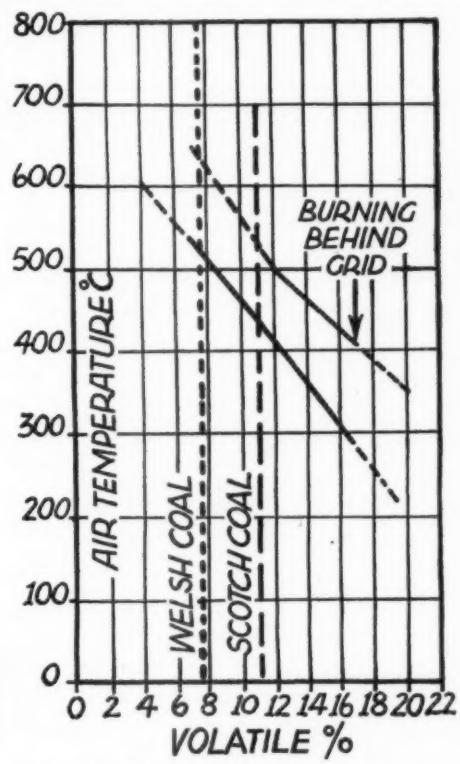


Fig. 2.—Balance to be observed between Volatile Content and Air Temperature.

Much attention has been given in many modern foundries to the sand and especially is this advisable where repetition production is concerned. When once the best type of sand has been established the factors generally controlled are moisture, permeability and compression strength, together with the amount of coal dust. Such properties are best determined on the standard apparatus recommended by the British Cast Iron Research Association, whilst a volatile content of the dry sand serves as a good check on the coal-dust content.

Samples of the castings were then shown illustrating the great improvement obtained from the same sand but employing a finer grade of coal dust, and the advantages to be derived by the careful use of finer sands generally was also illustrated.

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen.

Melting Plant.

Perhaps more important still have been the recent changes introduced by science into foundry-melting plant where again the assistance of the engineer has been enlisted by the metallurgist to achieve economy as well as accuracy and control of production. This is perhaps the latest research applied to the foundry and has resulted not only in greatly improved cupolas being made available, but also in the introduction of a new type of melting unit. The former are exemplified by those providing a secondary air supply above the melting zone, and the "Balanced-blast" cupola providing a more complete control over the primary or ordinary air supply by valves.

Balance-Blast Cupola.—The balanced-blast cupola[1] developed by Mr. J. E. Fletcher and the B.C.I.R.A. is the result of a close study of the conditions prevailing in the coke bed of the normally-designed cupola.

Mr. Fletcher ascertained that the total air passing through the outer annulus of the cross-sectional area of the melting zone, was approximately twice that passing through the core and

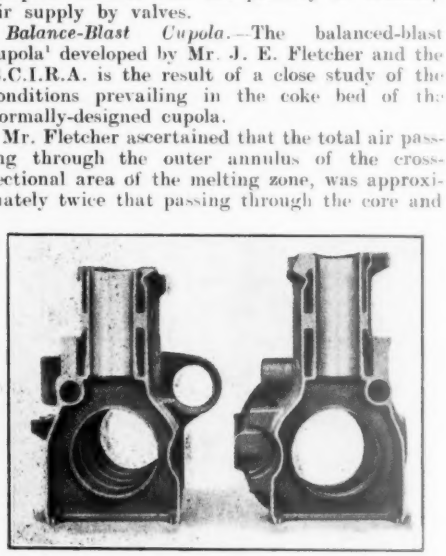


Fig. 3.—Sound Castings having widely varying Section-Thickness.

that the analyses of the gases leaving the top of the coke bed (about 2 ft. above the tuyeres) was as follows:—

	In outer annulus.		In core.	
	Weight Per cent.	Volume Per cent.	Weight Per cent.	Volume Per cent.
CO_2	24.20	16.9	14.70	9.0
CO	3.80	4.2	16.40	17.3
O_2	0.60	0.6	0.00	0.0
N..	71.4	78.3	68.9	73.7
Wt. air per lb. coke carbon ..	11.75 lbs.		8.1 lbs.	

About 3 in. above the tuyeres the analyses were :—

	In outer annulus.		In core.	
CO_2	3.6	2.4	12.5	9.3
CO	0.1	0.1	10.0	9.4
O_2	19.1	15.8	6.5	5.3
N..	77.2	81.7	71.0	76.0
Wt. air per lb. coke carbon ..	97.0 lbs.		11.65 lbs.	

From the above the oxidising character of the gases in the annulus is apparent. He also calculated the following heat volumes:—

To preheat 1 kilogram of cast iron to 1,140 deg. C. (melting point) requires 155 cals.
To melt 1 kilogram of cast iron requires 59 cals.
To superheat 1 kilogram of cast iron by 200 deg. (1,140 to 1,340 deg. C.) requires 33 cals.

To secure an equilibrium at the upper surface of the coke bed and to control the relatively small amount of the total air required for melting and preheating, adjusting valves are fitted on the main tuyeres and further tuyeres placed at a high level in the extended wind belt. By this means the air supply to the tuyeres is under complete control to suit varying conditions of melting required and more complete combustion of the coke secured.

1 B.C.I.R.A. Research Report, No. 91.

The Rotary Furnace.

A new type of melting unit is exemplified in the rotary melting furnace, a furnace primarily adapted to meet the more exacting and wider range of products which modern research on cast iron has brought into use. In connection with the rotary furnace, one design and its mechanical considerations have been dealt with by Mr. Scott in a previous lecture. It is proposed, therefore,

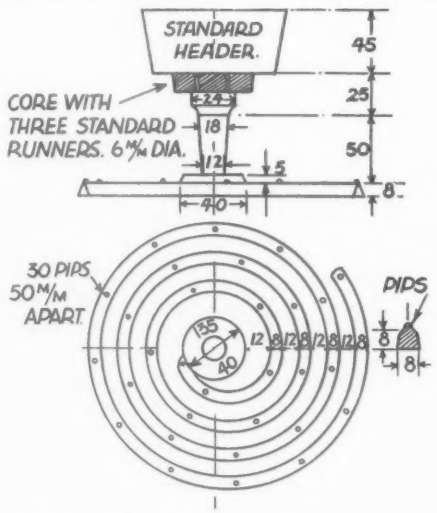


Fig. 4.—Sipp Life-test Arrangement.

to deal only, and in brief, with the metallurgical considerations, and it is convenient to take the process of manufacture first so that a better understanding of the products available may be obtained. Fig. 1 shows such a furnace in diagrammatic form. It has been observed that the mechanism of the process consists of introducing heat into the rotating furnace with the object of

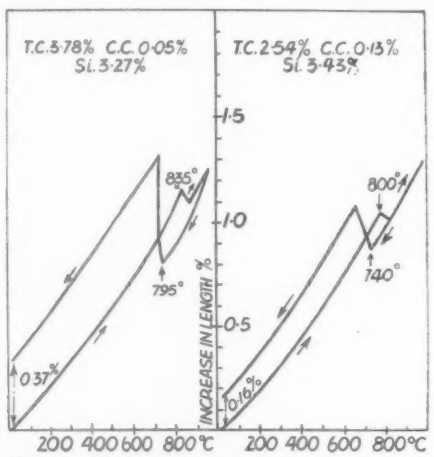


Fig. 5.—Dilometric Curves derived from High- and Low-T.C. Cast Irons.

raising the refractory lining to a very high temperature, the hot products of combustion then passing forward into the flues to the chimney stack.

The intense heat in the furnace lining is transmitted during rotation directly to the metal bath by actual contact, thus overcoming the heat-insulating power of the slag, which, however, protects the metal from contamination by gases. The heat is generated by the burning of pulverised coal on a refractory lath-type grid situated in the combustion chamber, somewhat on the principle of a Bunsen burner with its gauze flame carrier. The coal is carried in and burned by means of an air supply raised to a suitable temperature in a regenerator situated in the exhaust flues, and driven forward by the blower. The coal, except for that used in the initial lighting-up, is anthracitic and can be obtained from any suitable coal measure, typical analyses of such having already been given. Since the main feature is to concentrate the absorption of heat into the bath of metal, it is necessary to control the combustion of the coal—that is, the flame—at a position predetermined in the design of the furnace. This position is immediately in front of the grid in the combustion chamber.

Owing to the easier ignition of the higher-volatile coals the position would vary with this factor. Consequently for increased volatile in the fuel the temperature of the combustion air must be lowered to maintain the correct position. The following examples show the balance which has to be observed:—7 per cent. volatile requires 550 deg. C. air temperature: 11 per cent. volatile requires 450 deg. C. air temperature; 15 per cent. volatile requires 350 deg. C. air

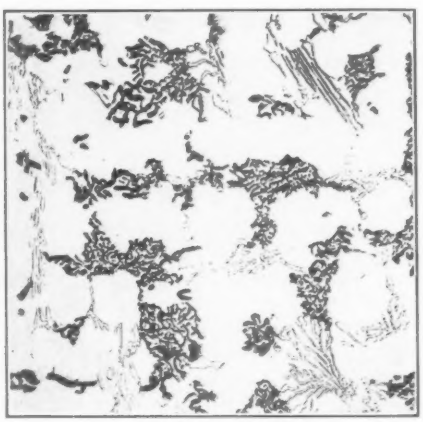


Fig. 6.—Nicrosilal Etched 10 per cent. HCl. × 200 dias.

temperature (see Fig. 2). The degree of pulverisation has also some influence on the position of combustion, but with suitable modern pulverising plant this can be closely regulated. A suitable condition of the coal is obtained when about 75 to 85 per cent. will pass through a 200 mesh with the coarser grades suitably balanced. The air temperature is controlled by the use of damper plates in the exhaust flues which include a by-pass direct to the chimney.

The type of slag produced in the rotary furnace is rather different from that produced in the cupola in that it contains much less iron oxide, which indicates practically a neutral atmosphere in the furnace, an abnormally low metal loss, and avoidance of undue oxidation of the metal or its ingredients by the transference of oxygen in the cycle of reactions between the metal and the slag.

Table II shows the slag in comparison with those from the cupola and the Siemens open-hearth furnace.

Table II.—*Slag Comparison.*

	Rotary slag Sesci.	Cupola slag.	Siemens slag.
Silica (SiO_2)	59.45	62.0	57
Ferrous oxide (FeO) ..	1.28	13.5	25
Alumina (Al_2O_3)	10.97	5.0	1
Manganese oxide (MnO) ..	4.70	7.0	10
Lime (CaO)..	22.40	9.0	5
Magnesia (MgO)	1.20	3.0	2
Sulphur (S)	Nil	0.5	Nil

The lining of the rotary furnace, put in by the aid of templates as in the Bessemer converter, is composed of such a material as to

embody high refractoriness, resistance to the abrasive action of the charge and the air-blast, little or no expansion or contraction, and an elasticity to withstand varying temperatures. Such materials are usually of a siliceous nature containing about 30 per cent. of clay and after ramming the lining is skin dried and fired, prior to glazing under full heat.

From the foregoing it will be seen that the rotary furnace provides conditions for producing metal, not only free from the effects of contamination necessarily associated with cupola practice, but one of a predetermined composition, and of a range hitherto not economically possible. The cupola, with its circumscribed heat range and direct contact between descending metal and ascending gases, has largely controlled and limited the composition and structure of cast iron produced therefrom.

It has long been recognised that vastly different structures could be obtained with the same composition, if only means of production were available economically and conveniently to provide a suitable range of the necessary conditions. In the many investigations into this new field of the structure of cast iron, in which the British Cast Iron Research Association has rendered invaluable service, it was early established that superheating of the metal and the amount of carbon present were the most prominent factors. The controlled effect of superheating cast iron is to produce in the final solid material a pearlite-fine graphite structure, to an extent dependent on the degree and length of time of such superheat. Such a structure, in addition to thus embodying the most desirable components of the iron, has the added interest and value of exhibiting a lower shrinkage and a more even grain-size for different metal thicknesses, a property hitherto attainable only by alloy additions or special processes.

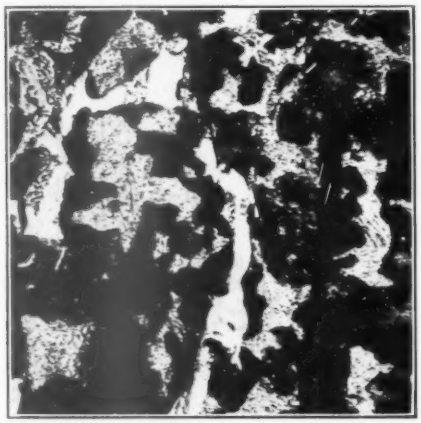


Fig. 7.—Sugar Roll. × 200 dias.

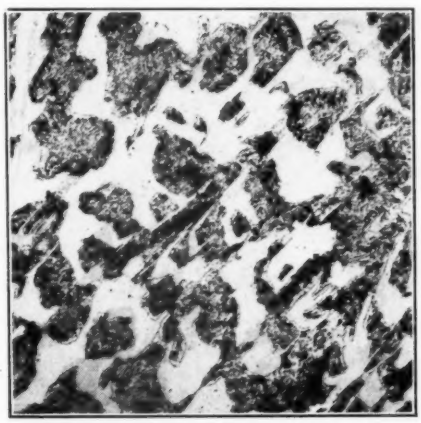


Fig. 8.—White Iron before Innoculation, Etched in Picric Acid. × 200 dias.

Fig. 9.—The Iron shown in Fig. 8 after Innoculation, Etched in Picric Acid. × 200 dias.

This is clearly illustrated in Fig. 3, which shows a casting varying in section from ¼ to 1½ in. and showing complete freedom from porosity with uniform close grain throughout all sections.

Actual fractures from various parts of this casting were exhibited further to illustrate this uniformity. The theory underlying this fine-graphite formation is generally ascribed to the more complete solution of the original flake graphite in the materials employed, with the consequent removal or reduction in size of graphite "nuclei," which would induce and form the starting point of larger flake graphite. This is only partially correct, however, and much investigatory work is proceeding in an effort to determine a more comprehensive understanding of the matter.

Some scientific evidence is, however, hereby shown for the use in most cupola charges of "scrap" which, whilst introducing a serious unknown factor into the calculation, is of finer-graphite form than "pig," due to its having been twice melted. The extent to which superheating should be carried out depends on the duties demanded of the castings produced from the metal, the proportion of pearlite retained being the main underlying factor. Apart from the microstructure, the amount of combined carbon is some guide in determining the correct conditions.

From the foregoing, it is natural to assume that a more complete control of total carbon in the metal would facilitate the production of a desired structure, if, for example, a low carbon could be employed. The superheat attainable in the rotary furnace renders this possible, since steel or any other low-carbon material can be melted with ease, and any degree of carbon introduced into the melt by this means, and adjusted by the addition of petroleum coke if necessary. The use of steel in the cupola charge, even if under limited control, is one evidence of the value of lower carbon towards improved structure. Low total-carbon cast iron, in addition to producing fine graphite, also produces a finer grain structure which, as one would expect, is responsible for great increase in strength. The new process of rotary melting has, therefore, provided a means of embodying the factors necessary to bridge the gap between grey cast iron and malleable cast iron, and by superimposing the malleable process thereon, of attaining strengths usually only attributed to steel.

Similarly for special-duty conditions, alloy cast iron of any desired composition can be made, either as a complete and separate melt where quantities warrant it, or by adding the alloying element, including carbon, in a residual furnace bath or in the ladle. Another feature of superheated iron which is worthy of note is the less effect thereon of the elements usually present in cast iron, such as silicon, manganese and phosphorus, so that a wider range of castings can be produced from the same composition, an advantage to be considered in many foundries at the present time. In the form of pig-iron, whether of alloy composition or not, a ready means of producing fine-grain cast iron from the cupola is thus rendered available.

With the wider range of compositions available some modification of existing test-pieces became necessary, and it is interesting to record one introduced to measure the fluidity of the metal. This was designed by Sipp, in Germany, and is of the design shown diagrammatically in Fig. 4, from which it will be seen that the test-piece is run under standard conditions so that all measurements are comparative. The complete test-piece of 1,500 mm. long (about 60 in.) has been attained on ordinary shop metal employed on thin castings. So elastic is the use of the rotary furnace that steel castings of an exceptionally high standard are readily produced giving daily test results of 30 to 35 tons tensile with up to 35 per cent. elongation and 40 per cent. reduction in area. It will thus be seen that a foundry equipped with such a plant is capable of handling all varieties of ferrous castings, including also malleable and the special duty alloy cast irons.

Cooling Effect.

The effect on the structure of the manner and rate of cooling is of equal importance to that of melting. Such rate varies from that of the heavy casting cooling down in the mould to that of the chilled casting, and the structure of the iron varies accordingly, both as regards the degree and disposition of the compound ingredients and also as to the grain size of the crystals. Again the constituents of the iron exercises an important bearing on the changes which take place when cast iron cools, influencing both the time and degree to which such changes take place.

For example, silicon and phosphorus notably amongst the usual constituents decrease the carbon eutectic point to an appreciable extent, varying the normal 4.3 per cent. carbon taken up by molten iron by approximately 0.3 times their own percentage thus affecting the solidification point of the iron. Again, certain other elements such as manganese, nickel and chromium greatly affect the temperature at which austenite (as in molten iron) transforms the martensite, thus changing from the non-magnetic to the magnetic state. The effect of alloy conditions to grey irons and the innoculation of white irons by certain elements have all received a considerable amount of attention by various workers and many useful alloy cast irons for special duty purposes are now available. Some of the commercial applications of these various researches are to be seen in the following examples.

Growth and Heat Resistant Irons.

Table II[2] shows the effect of silicon and carbon on the growth of cast iron, and Fig. 5 the curves of two typical examples from these figures showing the effect of silicon on the "critical temperature" and permanent expansion on both a high- and low-carbon cast iron. It will be noted that the permanent expansions are also considerably reduced by the use of the low total carbon and that silicon up to 3 per cent. increases the permanent expansion due to decomposition of the combined carbon in graphite and ferrite, but above this figure the less carbon solubility reduces the latter constituent. By introducing nickel and chrome (Nicrosilal)[3] a further improvement was obtained both as

2 A. L. Norbury and Morgan, Iron and Steel Institute, 1931.
3 B.C.I.R.A., Patent No. 378,508.

regards resistance to growth and also scaling together with ductility. An austenitic structure with 18 per cent. nickel, 6 per cent. silicon and 2 per cent. chromium, together with low total carbon proves a good machinable alloy. A micrograph of Nicrosilal (X200) is seen in Fig 6.

Non-Magnetic Cast Iron.[4]—This is a soft austenitic iron containing 6 per cent. manganese and 10 per cent. nickel, whilst a slightly harder variety is obtained if copper is introduced to replace some of the nickel.

Rolls for Special Purposes.—A structure specially designed for use in cane-sugar machinery and comprising troostite in a martensite matrix, together with cementite is obtained by the use of about 5 per cent. manganese. [Sample fractures and micrograph (see Fig. 7) from a roll were shown.]

Table III.—*Physical Differences between High and Low T.C. Irons.*

High Total Carbon Irons.				
Si. contents	1.60	3.27	4.38	5.64 per cent.
Perm. expansions ..	0.29	0.37	0.19	0.0 per cent.
Crit. points on heating	755	835	845	935 deg. C.
Crit. points on cooling	695	795	815	920 deg. C.
Low Total Carbon Irons.				
Si. contents	2.03	3.43	4.46	7.58 per cent.
Perm. expansions ..	0.14	0.16	0.15	0.0 per cent.
Crit. points on heating	760	800	875	Above 1,000deg.C.
Crit. points on cooling	685	740	810	Above 1,000deg.C.

Innoculation.—The addition in small amounts of such elements as nickel or silicon to a low silicon white iron has been found to produce very dense irons with remarkably high strengths. For example, under this treatment the strength was raised from 17 tons to 22 tons per sq. in. on bars up to 3¼ in. diameter. [Micrographs (X200 dia.) of such an iron before and after innoculation are shown in Figs. 8 and 9, and many examples of the special irons referred to were exhibited and created much interest.]

DISCUSSION.

Mr. Gresty, opening the discussion, referred to Mr. Dawson's statement when dealing with the rotary furnace that the lower the volatile content of the fuel the higher the air temperature necessary. What would happen if one took a coal of such high volatile content that one could not preheat the air? Further, should one aim at a low volatile coal and a high air temperature, or *vice versa?* It had struck him as remarkable that in spite of the very steep curves relating volatile content and air temperature which had been shown, the results, so far as melting was concerned, were similar. It was difficult to appreciate that the same results were obtained with such very different conditions.

If what Mr. Dawson had said was correct, it would appear that much trouble was unnecessarily undertaken on regeneration. Did the process simply preheat the air to use the exhaust gases? If such a wide range of coal could be used, why did they not use a local coal or a blend rather than bring the coal from a long distance?

Mr. Gresty also referred to the size of the graphite flakes as a practical index of strength. He did not think that that was invariably borne out in practice. There were many cases of cast iron containing apparently fairly coarse graphite giving high strengths and particularly high resistance to shock—probably due to the better continuity of the matrix.

In Table III, showing the relationship between growth and silicon content, it was surprising to find that the lowest silicon content given was 1.6 per cent. If the table had been continued into the range of lower silicon irons it would have been seen that very low silicon iron as far as growth was concerned was practically the same as the high-silicon irons. He suggested that the table would have been better if it had covered the whole commercial range.

Mr. Dawson, in reply, stated that he had only given the limits of coal compositions between which they worked. There was something more in it than just the burning of carbon and volatile matter. It became a question of the burning of coal for metallurgical operations and not for ordinary burning. Blended coal was not satisfactory, as it tended to separate on its way to the grid with uneven burning as a result. One could reach 20 per cent. volatile with the same results as when using lower volatile coal, but above 20 per cent. they were not so satisfactory.

Referring to the silicon content, he had not included the low-silicon irons because, for a melting pot, for example, the casting itself would be dead white if much lower silicon were employed. For 1½-in. thick wall he used 1.3 to 1.4 per cent. of silicon.

Interposing, Mr. Gresty said that Mr. Dawson was overlooking the Perlit Process, which allowed the use of very low silicon iron and Mr. Dawson agreed that if he had included this process it would have come at the lower end of the scale.

Mr. H. C. Jay said that he would like to carry further the point which had been raised regarding the volatile contents of fuel for rotary furnaces. After the furnace had been first heated up would it not be possible to go on to, say, a Durham grade of coal containing 26 per cent. of volatile? Such a coal, for example, would be quite suitable for pulverised-fuel firing of boilers, and it seemed regrettable that they had to bring coal from such a distance. He had not thought that Northumberland coal would do in any case, but that probably the Durham coal might be satisfactory.

Mr. Dawson, in reply, reminded Mr. Jay that the furnace in question was a relatively short one, and if coal too high in volatile were used the elongated flame resulting would pass into the flues with possible damage to the preheater tubes. Under these conditions also, combustion would be completed later in the furnace with the risk of an oxidising atmosphere being present at the grid end. Coals up to 15 per cent. volatile were quite often used, but for the above reasons it was not advisable to go very much higher.

Mr. Van der Ben referred to the specimens shown by Mr. Dawson when dealing with the subject of innoculation, and asked what would have been the effect if the extra 0.2 per cent. of silicon had been added to the furnace instead of to the ladle. Mr. Dawson replied that there was a very definite difference between the two ways of adding the silicon. If the silicon content had merely been raised in the ordinary way the iron would have been converted into grey iron and the strength would not have been raised.

Mr. Jay asked whether Mr. Dawson had had any experience with the addition of silicon to an already grey iron. They used to run a semi-Diesel mixture with 1.1 per cent. of silicon, which, when cast in a 1.2 diameter bar, it was grey. For other castings they used the same iron, but added silicon to the ladle and obtained greater strength, which would not have occurred if they had simply run the additional silicon through the cupola.

Mr. Dawson agreed that, under certain circumstances, the addition of silicon to the ladle would result in an increase in strength even on an already grey bar.

The meeting concluded with a vote of thanks to the lecturer, which was proposed by Mr. Carmichael and passed unanimously.

[4] S. E. Dawson, F.T.J., vol. 29.

Better Outlook for Scrap.

By "Onlooker."

The fillip to new metal values, given by the modest rise in commodity prices which followed hard on the heels of the American banking crisis, has come as a real relief to dealers in old metals, whose plight during the past months has been unenviable. By comparison with the dealer in virgin metals, who has at least been reasonably sure of getting a fair tonnage of the raw material in which he trades for daily sales, the scrap-metal merchant has been faced with the problem of obtaining a sufficient supply at the right price to hold his business connection together. Therein lies one of the great difficulties for the merchant in whatever line he may be engaged, for at any cost he must always be ready to buy or to sell. Consumers grow tired of approaching him for supplies after they have found on two or three occasions that he has nothing to offer.

It is, of course, obvious that, except in those rare cases where foundries run working entirely on scrap, the buyer is going to make quite sure of a reasonable margin below virgin metals before he makes a purchase of material which is inferior in quality on account of its secondary nature and losses from dirt and impurities. Old metals must, therefore, always be offered to prospective customers at something below the official Metal Exchange quotations for copper, lead, etc., and it is when these fall to an abnormally low level that the trouble begins. In secondary material production costs include breaking down and preparation of the metal for the consumer, and in this manner a fairly heavy bill for grading, sorting, cutting up, etc., is incurred. All this has to be covered in the selling price before a profit is obtained, and when new metal values are unduly depressed, it is extremely difficult to realise a figure which will cover the original cost plus the addition for converting into marketable form.

The scrap-metal merchant is, of course, dependent for his supplies on first holders, *i.e.*, shipbreakers, public-work contractors, Government Departments and the like, and should these people make up their minds that to sell at any particular juncture is to sacrifice their stock needlessly, then the dealer in old metals can only shrug his shoulders and try elsewhere. Latterly there has been a good deal of this sort of thing going on, and rather than lose touch with customers the scrap merchants have been compelled to make "bear" sales, when such transactions could be arranged for forward dates, trusting to some decline in values and a good deal to luck to secure the necessary cover. Business of this kind is speculative, and usually distinctly unremunerative, so that any improvement in the general situation which makes for a higher price level likely to encourage metal holders to let go is welcomed by the scrap dealers anxious to secure their raw material. It is an open secret that some very considerable tonnages of old metal are lying in warehouses in this country, and if the price of copper rose by £10 per ton, the holders would still be compelled to face a loss in selling.

The absence of American material and a drain to the Continent have both tended to shorten supplies in this country, so that the modest rise in values of copper and spelter which occurred recently was hailed with relief, not only by the scrap merchants themselves, but also by the consumers, who have found by bitter experience that when prices are "down and out," not only is material scarce, but quality suffers considerably as a result of efforts to wring some sort of profit out of the transaction. A falling-off in quality leads immediately to complaints, and sometimes to friction which may mean the loss of a good account, not to mention the possibility of recourse to arbitration and resultant expense.

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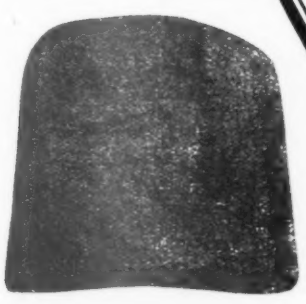

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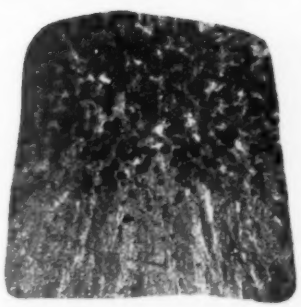

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TELEGRAMS "CLOSEWORK GATESHEAD"

This Week's News in Brief.

Trade Talk.

An order for six 12-ft. Bermuda rigged centre-board boats has been placed with Messrs. James Adam & Sons, Gournock.

Messrs. Thos. W. Ward, Limited, of Sheffield, have bought two ships, the "Thessaly" (3,135 tons) and the "Lutterworth," both for scrap.

Messrs. Scott's Shipbuilding & Engineering Company, Limited, Greenock, are to erect an extension to the platers' shed at their Cartsburn Dockyard.

The Caledon Shipbuilding & Engineering Company, Limited, launched from their Stannergate yard the "Fiona," a cargo boat built to the order of the Colonial Sugar Refining Company, Limited, Australia.

Messrs. John G. Kincaid & Company, Limited, Greenock, have received an order for two British-Kronhout oil engines. One is for a motor coaster to be built by the Ardrossan Dockyard, Limited, for London owners.

The Board of Trade announce that an Order-in-Council was made on March 16 under Section 2 of the Merchandise Marks Act, 1926, which requires imported wrought hollow-ware of iron or steel to bear an indication of origin.

Messrs. William Baird & Company, Limited, have decided to blow in two blast furnaces at their Gartsherrie Works, Coatbridge, which have been out of blast since July, 1932. Preparations are being made for the rekindling at once.

The galvanising plant at the Whitford Steel Sheet and Galvanising Works at Briton Ferry has been restarted. The mills at these works restarted on the previous day, absorbing 300 men, and altogether 450 hands have returned to work.

Owing to sudden illness, the lecture which was to have been given by Mr. J. B. Corrie on "The Preparation of Moulding Sand" at the seventh meeting of the Newcastle and District Branch of the Institute of British Foundrymen was abandoned.

A minor boom in the ship-breaking industry is being experienced at Bo'ness. The Anchor Brocklebank liner "Holywell," of 4,867 tons, is the latest vessel to be beached at the Bridgeness yard of Messrs. P. & W. MacLellan, Limited, for demolition.

Mr. John Docherty, of Cambuslang, received severe injuries while working a magnet crane in the Hallside Steelworks, Newton. He was removed to the Royal Infirmary, Glasgow, and found to have both legs and several ribs broken, in addition to cuts about the head.

It was announced recently in the Australian Parliament that the British and Commonwealth Governments are negotiating with regard to the Australian iron and steel duties and that the British Government are sending a representative to Australia to discuss the subject.

A factory for making plumbago crucibles has recently been started up by the Birmingham Crucible Company. The new industry is already in operation at Witley Works, Halesowen, about fifty men being employed. A refining plant for preparing the graphite is part of the equipment.

Improved trade in Clyde shipbuilding, engineering and other heavy industries, and a reduction in the number of unemployed blacksmiths, are referred to by Mr. William Lorimer, general secretary of the Associated Blacksmiths' and Smithy Workers' Society, whose headquarters are in Glasgow, in his quarterly report issued last week.

A marked recovery in steel production in Canada has occurred since the beginning of the year. The output was 29,986 tons in December, 1932, 40,766 tons in January and rose still further to 41,387 tons in February last. Pig-iron production shows the same trend, rising from 22,842 tons in December to 27,031 tons in January and 28,399 tons in February, compared with a low record of 9,378 tons in August, 1932.

It is reported in the German newspapers that the South African railways are in negotiation with Continental producers for the purchase of 27,000 tons of steel sleepers, in addition to those already ordered, for which British producers were unable to make a favourable offer. On the other hand, it is recorded that an important order for rails had been entirely placed in England. The Spanish steelworks, which a short time ago obtained an order for 32,000 tons of rails from the Argentine, are now endeavouring to get orders from South Africa, and have underquoted the Irma by 15s. per ton.

The Import Duties Advisory Committee give notice of applications for an increase of import duty on cast-iron porcelain-enamelled baths, and for drawback under Section 9 of the Finance Act, 1932, in the case of top-dyeing machines in respect of the castings and sheets of Krupp's V4A welding-quality stainless steel used in their manufacture. Any representations which interested parties may desire to make should be addressed in writing to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, London, S.W.1, not later than April 10 next.

The Association of Scientific Workers and the British Institute of Social Service, of 70, Victoria Street, London, S.W.1, are engaged in compiling a Handbook of Extra-University Research in Pure and Applied Science, in which it is proposed to give data concerning commercial, endowed and private research laboratories. They do not wish to include laboratories and other institutions devoted solely to testing materials and products, collecting data and other work not of a developmental and original character. Firms doing work of the type which the Association indicates are advised to communicate with that body.

The report of the Bethlehem Steel Corporation for 1932 shows that the total income of the Corporation and its subsidiaries for the year, before charges for interest and depreciation, was $594,138, as compared with $21,386,694 for the preceding year. After deducting interest and other charges of $6,896,980 and depletion and depreciation charges of $13,101,589 there was a deficit of $19,404,431 for 1932, as compared with a net income of $115,745 for the preceding year. A statement by Mr. Charles M. Schwab, chairman of the board, shows that operations of the Corporation's steel plants for the year averaged 16.9 per cent. of capacity, as compared with 38.6 per cent. in 1931. There was a gradual decline in the rate of operations during the first eight months of 1932, followed by a slight temporary improvement. The low point in the rate of operations for the year was reached in December.

Messrs. Stewarts & Lloyds, Limited, have, in the course of the past few years, remodelled and modernised their Bilston Works (formerly Messrs. Alfred Hickman, Limited). The works are intended primarily to supply the varying qualities of steel which are necessary for tube making. They are continuing this policy and, at the present time, the plant is one of the most fully occupied steel plants in the country. The latest addition to the plant which is being made is a reheating furnace to serve the mills used in producing bars for seamless steel tubing. The furnace, which, it is understood, embodies several new features, has been designed by the works staff in collaboration with the company's central research board and technical departments. It is expected to go into production towards the end of this month, and when it operates it will augment the already considerable capacity of the Bilston mills, as far as bars for tube-making are concerned.

Personal.

Mr. Walter Elliott, for many years a prominent foundry trade-union leader, has died at his home in Marlborough Street, South Shields, in his 80th year.

Mr. O. Waldrich, of Siegen, has had the degree of Dr. Ing. h.c. conferred on him by the Technical High School Fridericiana in Karlsruhe, the oldest Technical High School in Germany, in recognition of his services in the construction and manufacture of heavy machine tools.

Wills.

Smith, Henry, ironmoulder, Stenhousemuir	£496
Spencer, John, of Sheffield, tool manufacturer	£4,598
Caird, P. T., of Greenock, head of the former firm of Caird & Company (now Messrs. Harland & Wolff, Limited), shipbuilders and engineers	£309,239

Obituary.

Mr. Francis Albert Hatfield, formerly works manager of Messrs. Joseph Rodgers & Sons, Limited, of Sheffield, died on March 16, aged 77.

Mr. Frederick Cresswell, for many years manager of the foundry of the Clay Cross Company, Limited, whom he served for many years prior to his retirement in 1929, has died at the age of 79.

Mr. James Walker, an acetylene welder, of Foundry Road, Parton, near Whitehaven, Cumberland, was killed as a result of an explosion in a shed at the United Steel Company's Lowca by-products works.

Dr. William Cawthorne Unwin, Professor Emeritus of the Central Technical College, City and Guilds' Institute, South Kensington, who has died at his London home in his 95th year, was at one time President of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. In 1921 he was awarded the Kelvin Medal.

Mr. W. J. Potter, who died recently, joined the staff of Messrs. W. T. Henley's Telegraph Works Company, Limited, in 1887, and thus had 46 years' association with the company. He was secretary of Henley's Telegraph Works (South Africa) Company, Limited, from 1903 to 1914. Mr. Potter was appointed a director of the company in May, 1913. He retired from his staff position on March 31, 1932, but continued in his capacity as a director.

Mr. A. G. Jeynes, of Stockton, died on Saturday, March 18, following a motor accident. Mr. Jeynes was an engineer of prominent standing. He spent nearly the whole of his working life with Messrs. Ashmore, Benson, Pease & Company, Limited, excepting for about nine years, when, in 1904, he left the firm and joined the late Mr. Smithers in partnership as engineers at Middlesbrough. This firm dissolved in 1913, when Mr. Jeynes returned to Messrs. Ashmore, Benson, Pease & Company's Parkfield works at Stockton as works manager. In this position he continued until about three years ago, when, at the age of 70, he sought to retire, but was induced by the firm to continue in an advisory capacity.

Company Reports.

Thos. Firth & John Brown, Limited.—The directors are of opinion that it is not advisable at present to pay any dividend on the preference shares.

John Baker & Bessemer, Limited.—Loss for 1932, £7,822, before making allowance for depreciation; brought in, £17,022; carried forward, £9,199.

Coltness Iron Company, Limited.—Brought in, £156,172; final dividend on the ordinary shares of 5 per cent., making 8 per cent. for 1932; to redemption and depreciation account, £60,000; carried forward, £164,337.

Cammell, Laird & Company, Limited. — Trading profit, £47,819; brought in, £115; net profit, after crediting income from investments, etc., and charging depreciation and debenture interest and expenses of capital reconstruction, £626; carried forward, £741.

British Thomson-Houston Company, Limited.—Profit for 1932, £392,015; brought in, £221,265; interest charges, £99,743; depreciation, etc., £146,992; preference dividends, £78,749; dividend of 4 per cent. on the ordinary shares, £60,000; carried forward, £227,795.

Morgan Crucible Company, Limited. — Trading profit, after providing for depreciation, £214,159; brought in, £633; net profit, £170,504; dividends on the preference and preferred ordinary shares, £41,625; interest on 7 per cent. obligations, £3,836; interim dividend on the deferred ordinary shares, £30,347; final dividend on the deferred ordinary shares of 2½ per cent., £40,462; capitalisation of 5 per cent. obligations, £53,950; carried forward, £917.

The complete reopening of the Skinningrove Iron and Steel Works, Saltburn, will be accomplished on Monday, April 3. The Loftus ironstone mine was reopened on March 20, and two blast furnaces were brought into commission again last week. This week the steel-melting furnaces are being started, and on April 3 operations at the works will be in full swing. They have been closed since November for the purpose of effecting various improvements and for reorganisation

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Raw Material Markets.

Several sections of the iron and steel markets report increased business, and the general trend of activity seems to be an improving one. The expansion in the pig-iron demand is slow, but finished steel business, if irregular, is on the up grade. The production of pig-iron is now larger, two or three additional furnaces having been put into commission. The Skinningrove Iron and Steel Works have now been reopened. Messrs. Richard Thomas & Company, Limited, announce their decision to restart their Redbourne iron and steel works, at Scunthorpe, Lincolnshire, as soon as possible.

Pig-Iron.

MIDDLESBROUGH.—The outlook in this area is considerably brighter. The Skinningrove plant resumed operations last week, two blast furnaces being blown in and the Loftus iron mine restarted. The steel furnaces go into operation this week and the rolling mills next week. Sufficient orders are in hand to ensure regular working during April. The heaviest clearances of pig-iron for about twelve months are now being made from the Tees, and further orders are being secured from Scottish consumers. Scotland continues to take the bulk of Cleveland's marketable iron, but preferential rates are quoted, the price of No. 3 Cleveland G.M.B. beyond the border being 59s. 9d. per ton, delivered Falkirk, and 62s. 9d. delivered Glasgow. In the Middlesbrough area, the fixed minimum is 62s. 6d. and to other North-East Coast destinations the delivered price is 64s. 6d. per ton.

The demand for East Coast hematite is definitely broadening. Apart from the usual despatches to Sheffield and South Wales, new business has been secured in Scotland, whilst the makers are increasing their connections with Italy and Japan. There are also hopes of sales to one or two of the near-Continental works. Quotations remain low at 59s. per ton for mixed numbers and 59s. 6d. for No. 1 quality.

LANCASHIRE.—Deliveries of pig-iron to foundries this month have shown little or no improvement on February's level, and current business only relates to small parcels to cover consumers' immediate needs. There has been little or no change in prices. Midland brands—Staffordshire and Derbyshire No. 3—are both quoted for delivery to users in the Manchester zone on the basis of 67s. per ton, with North-East Coast iron nominally at the same figure. Northamptonshire is on offer at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 82s., West Coast hematite at about 80s. 6d. and East Coast hematite at 75s. 6d. Supplies of light machinery scrap are plentiful, and large supplies are available at about 35s. per ton, delivered to users' works.

MIDLANDS.—Conditions in the pig-iron market are largely unchanged, few foundries being really busy, but it is hoped that some improvement will shortly take place. Prices are unaltered at 62s. 6d. for Northants No. 3 and 60s. for Derbyshire, North Staffordshire and Lincolnshire No. 3, delivered to Birmingham and Black Country stations. Supplies of Cleveland No. 3 foundry are coming through, also at 66s. In connection with the better grades of iron, fair tonnages of medium- and low-phosphorus iron are consumed in the Black Country district, prices ranging from 69s. to 85s. per ton delivered. Scottish iron ranges from 82s. 6d. to 85s., delivered Birmingham district, for No. 3. East Coast and Welsh hematite vary, according to quality and tonnage, from 73s. to 77s. 6d., West Coast hematite being still controlled at 84s. 6d. delivered.

SCOTLAND.—Pig-iron consumption in this country makes little headway on the whole. Prices of Scottish iron remain at the official minimum of 65s. per ton for No. 3 foundry, with 2s. 6d. extra for No. 1, at the furnaces. Another furnace has been blown in, on basic iron, bringing the number of furnaces in blast in Scotland up to five—three on foundry iron, one on hematite and one on basic, out of 77 built. The light-castings section of the trade in Falkirk is very quiet. Small lots of Middlesbrough iron are coming forward, at 62s. 9d. at Glasgow and 59s. 9d. at Falkirk, Northamptonshire irons being at 57s. 6d at Falkirk for No. 3. Scottish hematite is at 66s., West Coast hematite 68s. 6d. and Lincolnshire, Scottish and Indian basic all 57s. 6d., delivered.

Coke.

There is little activity in the foundry-coke market, forward business remaining very scarce. Best Durham coke ranges from 36s. 6d. to 38s. 6d., and Welsh coke from 30s. to 46s., according to analysis. These prices are delivered Birmingham and district.

Steel.

Business in semi-finished steel continues to be disappointing. Very few orders for Continental material are reported, and there seems little disposition on the part of the Continental makers to press sales. On the other hand, the British producers complain of the small tonnages of the orders they receive. The demand in this branch of the trade, however, seems to be expanding. Business in finished steel is quiet after showing some improvement. Transactions in Continental material are reported on a rather larger scale than of late, but most of the business is still in the hands of British manufacturers.

Scrap.

Works in the Cleveland area are still buyers of heavy metal, and are offering 42s. 6d. and more for ordinary quality, good machinery quality being at about 45s. per ton, delivered. A fair rate of activity is being maintained at the Midlands foundries, and there is a good demand for scrap iron in that area, heavy machinery being at 47s. 6d., heavy pipe and plate scrap at 42s. 6d. and clean light at 39s., delivered. The demand for machinery scrap iron in Scotland has fallen off somewhat, many of the foundries having bought recently, and no more than 50s. to 51s. 3d. is being paid. Ordinary cast iron is at 47s. 6d. Heavy cast iron in large pieces and furnace sizes continues to sell in South Wales at 45s. Light cast iron is firm at 39s. to 40s., but there is only a sluggish business in machinery scrap at 48s. to 50s.

Metals.

Copper.—This market has been dull and featureless lately, little business being done with consumers in this country. In view of the immense stocks of copper in existence on both sides of the Atlantic, it is useless to hope for a recovery in prices until there is a definite quickening of activity in the consuming industries.

Prices have been :—

Cash.—Thursday, £28 5s. to £28 6s. 3d.; Friday, £28 12s. 6d. to £28 13s. 9d.; Monday, £28 11s. 3d. to £28 12s. 6d.; Tuesday, £28 2s. 6d. to £28 5s.; Wednesday, £28 2s. 6d. to £28 3s. 9d.

Three Months.—Thursday, £28 11s. 3d. to £28 12s. 6d.; Friday, £28 17s. 6d. to £28 18s. 9d.; Monday, £28 16s. 3d. to £28 17s. 6d.; Tuesday, £28 7s. 6d. to £28 10s.; Wednesday, £28 7s. 6d. to £28 10s.

Tin.—There has been a fair demand from consumers in this country, although the market has fallen off on the Continent. Stocks in this country, however, are being steadily reduced, and to this fact may be attributed the comparative steadiness of this metal at the present time.

Prices of standard tin have been :—

Cash.—Thursday, £149 5s. to £149 7s. 6d.; Friday, £151 5s. to £151 10s.; Monday, £151 7s. 6d. to £151 10s.; Tuesday, £150 2s. 6d. to £150 5s.; Wednesday, £150 15s. to £150 17s. 6d.

Three Months.—Thursday, £150 to £150 2s. 6d.; Friday, £151 17s. 6d. to £152 2s. 6d.; Monday, £152 5s. to £152 7s. 6d.; Tuesday, £150 17s. 6d. to £151; Wednesday, £151 12s. 6d. to £151 15s.

Spelter.—Messrs. Rudolf Wolff & Company state that the market "has been irregular and on the whole easier, but has improved latterly. The weaker tendency which earlier was displayed must be ascribed to the unsettled conditions prevailing on the Continent and the uncertainties which surround the situation in America. Meanwhile, demand on the part of consumers in this country remains very quiet and similar conditions are reported on the Continent, whilst business of a speculative character has been on a very reduced scale. It cannot be said, however, that sellers have at any time shown anxiety to effect sales, the weakness lying more particularly in lack of interest on the part of buyers."

Price fluctuations :—

Ordinary. — Thursday, £14 15s.; Friday, £14 17s. 6d.; Monday, £14 15s.; Tuesday, £14 11s. 3d.; Wednesday, £14 13s. 9d.

Lead.—Messrs. Henry Gardner & Company report that "after a small bout of profit-taking, fortified by the continued good demand from consumers, more especially in this country, values have shown considerable firmness, and prospects for this metal appear to be very greatly improved. Should the present rate of consumption be maintained, there is no doubt that stocks will be considerably reduced."

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £10 12s. 6d.; Friday, £10 13s. 9d.; Monday, £10 12s. 6d.; Tuesday, £10 10s.; Wednesday, £10 6s. 3d.

Some Brass Foundry Problems.

(*Concluded from page* 222.)

nium castings is that there is a more extensive use of chills in the mould than is usual with other metals. In iron castings the chill hardens that particular place, but with aluminium no such disadvantage arises.

The one purpose of chilling aluminium is to accelerate the freezing of that portion of the casting so as to obtain a uniform cooling throughout the casting. The greatest objection to chills is due to their sweating, with the result that the surface will probably be covered with blow-holes. If, however, the chills are coated with a suitable dressing, this disadvantage can be eliminated.

A satisfactory cheap dressing for such chills is a mixture of methylated spirits and ordinary whitening, mixed into a good, thick paste and applied with a brush immediately prior to casting.

If aluminium is heated up to 860 deg. C. and teemed, the casting will be a waster through porosity, but if the metal is cooled down to 680 deg. C., the castings will be perfectly sound. This is due to the oxygen absorbed being thrown out during the cooling process.

Aluminium cast hot has a brownish skin, and very often, when the casting is being skin-machined, holes appear as small specks throughout the casting. These defects would in all probability disappear if the alloy had been cast at a lower temperature.

Institute of Metals.

At the recent Annual General Meeting of the Institute of Metals, held in London, the following officers were declared to be elected for the year 1933-34 :—*President:* Sir Henry Fowler, K.B.E., LL.D., D.Sc. *Vice-Presidents:* C. H. Desch, D.Sc., Ph.D., F.R.S.; Prof. R. S. Hutton, D.Sc., M.A. *Members of Council:* Engineer Vice-Admiral Sir Robert Dixon, K.C.B., D.Eng.; Wesley Lambert, C.B.E., A.K.C.; H. C. Lancaster; A. H. Mundey; A. J. G. Smout; F. Tomlinson.

The Silver Jubilee Meeting of the Institute will be held in Birmingham from September 18 to 21. It was in Birmingham that the first general meeting of the Institute was held in the autumn of 1908, under the presidency of the late Sir William H. White, K.C.B., F.R.S.

Indian Pig-Iron Exports, 1932.

British India during the second six months of 1932 exported 92,048 tons of pig-iron, as against 158,301 tons in the first half of the year. The total exports for the year amounted to 250,349 tons, as compared with 318,994 tons in 1931 and 502,629 tons in 1930. The annnal exports in 1932 (1931) included 85,332 (51,600) tons to Great Britain, 8,560 (14,552) tons to Germany, 103,724 (157,116) tons to Japan, 26,978 (60,121) tons to the United States, and 25,755 (35,305) tons to other countries. During the last six months of the year, exports to Japan expanded steadily, being 506 tons in July, 2,286 tons in August, 2,483 tons in September, 2,926 tons in October, 4,572 tons in November, and 5,485 tons in December.

MORE FOUNDRIES
USE
STERLING BOXES!

The continued and increasing popularity of the Sterling Moulding Box in the foundries of this country is convincing proof that the STERLING Solid Ribbed Rolled Steel BOX has more than justified itself as

THE GREATEST ECONOMY YOU CAN INTRODUCE INTO YOUR FOUNDRY.

To-day the need for economy is greater than ever before. If therefore you are not a user of STERLING BOXES you should write for our latest catalogue and investigate the Sterling Service without delay.

Sterling

FOUNDRY MOULDING BOXES
FOUNDRY WHEELBARROWS
CORE OVEN TRUCKS
PATTERN PLATES & ODDSIDES
STEEL BOTTOM PLATES
MOULDING BOX PINS

STERLING FOUNDRY SPECIALTIES Limited
LONDON OFFICE:—13 VICTORIA STREET, S.W.1
AGENTS AT MANCHESTER, GLASGOW & NEWCASTLE-ON-TYNE.
BEDFORD

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	2	6
Three months	28	7	6
Electrolytic	32	10	0
Tough	30	5	0
Best selected	30	15	0
Sheets	61	0	0
India	40	5	0
Wire bars	33	5	0
Do., April	33	0	0
Do., May	33	0	0
Ingot bars	33	5	0
H.C. wire rods	35	10	0
Off. av. cash, February	28	10	6¾
Do., 3 mths., February	28	15	4⅞
Do., Sttlmnt., February	28	10	6
Do., Electro, February	32	14	9¾
Do., B.S., February	31	3	9
Do., wire bars, February	32	18	6
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	7⅞d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7¼d.
Wire	7¼d.
Rolled metal	7d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	150	15	0
Three months	151	12	6
English	151	15	0
Bars	154	0	0
Straits	155	17	6
Australian	153	12	6
Eastern	156	5	0
Banca	156	2	6
Off. av. cash, February	148	12	7½
Do., 3 mths., February	149	1	2½
Do., Sttlmt., February	148	12	6

SPELTER.

	£	s.	d.
Ordinary	14	13	9
Remelted	14	0	0
Hard	11	15	0
Electro 99.9	17	5	0
English	15	7	6
India	13	10	0
Zinc dust	20	0	0
Zinc ashes	2	5	0
Off. aver., February	13	19	10½
Aver. spot, February	13	17	3½

LEAD.

	£	s.	d.
Soft foreign ppt.	10	6	3
Empire	10	15	0
English	11	5	0
Off. average, February	10	11	6
Average spot, February	10	8	7½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do., V.M. ex-whse.	23	0	0
Rods	26	0	0
Boiler plates	22	0	0
Battery plates	—		

ANTIMONY.

	£	s.	d.	£	s.	d.
English	37	10	0 to	42	10	0
Chinese				27	15	0
Crude				—		

QUICKSILVER.

	£	s.	d.
Quicksilver	9	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro silicon—			
25%	7	15	0
45/50%	13	17	6
75%	19	12	6
Ferro-vanadium—			
35/50%	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free of Mo.	6/3 per lb.		
Ferro-titanium—			
23/25% carbon-free	10d. lb.		
Ferro-phosphorus, 20/25%	£17	17	6
Ferro-tungsten—			
80/85%	1/7½ lb.		
Tungsten metal powder—			
98/99%	1/10½ lb.		
Ferro-chrome—			
2/4% car.	£29	5	0
4/6% car.	£22	15	0
6/8% car.	£22	0	0
8/10% car.	£21	17	6
Ferro-chrome—			
Max. 2% car.	£34	10	0
Max. 1% car.	£36	5	0
Max. 0.70% car.	£40	2	6
70%, carbon-free	11d. lb.		
Nickel—99.5/100%	£240 to £245		
"F" nickel shot	£216	0	0
Ferro-cobalt	7/3 lb.		
Aluminium 98/99%	£100	0	0
Metallic chromium—			
96/98%	2/8 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11	5	0
76/80% packed	£11 15 0 to £12	5	0
76/80% export (nom.)	£9	15	0
Metallic manganese—			
94/96% carbon-free	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
- Rounds and squares, 3 in. and over 4d. lb.
- Rounds and squares, under ½ in. to ¼ in. 3d. lb.
- Do., under ¼ in. to 1/8 in. 1/– lb.
- Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. 3d. lb.
- Do., under ½ in. × ¼ in. 1/– lb.
- Bevels of approved sizes and sections 6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	5	0
Bundled steel and shrngs.	1	17	6 to 2	1	6	
Mixed iron and steel	2	0	0 to 2	1	6	
Heavy cast iron				2	5	0
Good machinery	2	8	0 to 2	10	0	
Cleveland—						
Heavy steel	2	0	0 to 2	2	6	
Steel turnings				1	12	6
Cast-iron borings				1	3	6
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap	2	2	6 to 2	5	0	
Midlands—						
Light cast-iron scrap				1	19	0
Heavy wrought iron				2	10	0
Steel turnings, f.o.r.				1	5	6
Scotland—						
Heavy steel	1	18	9 to 2	0	0	
Ordinary cast iron				2	7	6
Engineers' turnings				1	12	0
Cast-iron borings				1	12	6
Wrought-iron piling				2	5	0
Heavy machinery	2	10	0 to 2	11	3	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	21	0	0
Brass	16	0	0
Lead (less usual draft)	9	10	0
Tea lead	8	0	0
Zinc	8	10	0
New aluminium cuttings	74	0	0
Braziery copper	19	0	0
Gunmetal	18	0	0
Hollow pewter	80	0	0
Shaped black pewter	60	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/–
Foundry No. 3	62/6
,, at Falkirk	59/9
,, at Glasgow	62/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/–
,, No. 3 fdry.	66/–
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/–
,, fdry. No. 3	66/–
,, fdry. No. 1	69/–
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/–
Hem. M/Nos. d/d	66/–
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/–
Clyde, No. 3	82/–
Monkland, No. 3	82/–
Summerlee, No. 3	82/–
Eglinton, No. 3	82/–
Gartsherrie, No. 3	82/–
Shotts, No. 3	82/–

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	10	0 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	10	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	0	0 to	9	0	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	6	15	0 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 & up.			
Black sheets, 24g. (10-t. lots)				9	10	0
Galv. cor. shts.	,,			11	15	0
Galv. flat shts.	,,			12	5	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	0	0 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11⅞d.
Rods	10½d.
Tubes	15d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.60
Wire nails	1.85
Plain wire	2.10
Barbed wire, galv.	2.35
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/– to 22/6
,, furnace	16/– to 17/–
Durham and Northumberland—	
,, foundry	21/– to 25/–
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	15/9
,,	28×20 ,,	31/6
,,	20×10 ,,	22/7½ to 23/–
,,	18¾×14 ,,	16/4½ to 16/7½
C.W.	20×14 ,,	14/6 to 15/–
,,	28×20 ,,	30/3
,,	20×10 ,,	22/–
,,	18¾×14 ,,	15/10½

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	10	0 to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	5	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

XUM

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Mar.	23 ..	28	5	0	inc. 3/9
,,	24 ..	28	12	6	,, 7/6
,,	27 ..	28	11	3	dec. 1/3
,,	28 ..	28	2	6	,, 8/9
,,	29 ..	28	2	6	No change

Electrolytic Copper.

		£	s.	d.	
Mar.	23 ..	32	10	0	No change
,,	24 ..	32	15	0	inc. 5/-
,,	27 ..	32	15	0	No change
,,	28 ..	32	10	0	dec. 5/-
,,	29 ..	32	10	0	No change

Standard Tin (cash).

		£	s.	d.	
Mar.	23 ..	149	5	0	inc. 15/-
,,	24 ..	151	5	0	,, 40/-
,,	27 ..	151	7	6	,, 2/6
,,	28 ..	150	2	6	dec. 25/-
,,	29 ..	150	15	0	inc. 12/6

Tin (English ingots).

		£	s.	d.	
Mar.	23 ..	150	0	0	No change
,,	24 ..	152	5	0	inc. 45/-
,,	27 ..	152	5	0	No change
,,	28 ..	151	0	0	dec. 25/-
,,	29 ..	151	15	0	inc. 15/-

Spelter (ordinary).

		£	s.	d.	
Mar.	23 ..	14	15	0	inc. 3/9
,,	24 ..	14	17	6	,, 2/6
,,	27 ..	14	15	0	dec. 2/6
,,	28 ..	14	11	3	,, 3/9
,,	29 ..	14	13	9	inc. 2/6

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
Mar.	23 ..	17	10	0	inc. 5/-
,,	24 ..	17	10	0	No change
,,	27 ..	17	10	0	,, ,,
,,	28 ..	17	5	0	dec. 5/-
,,	29 ..	17	5	0	No change

Zinc Sheets (English).

		£	s.	d.	
Mar.	23 ..	24	0	0	No change
,,	24 ..	24	0	0	,, ,,
,,	27 ..	24	0	0	,, ,,
,,	28 ..	24	0	0	,, ,,
,,	29 ..	24	0	0	,, ,,

Lead (English).

		£	s.	d.	
Mar.	23 ..	12	0	0	No change
,,	24 ..	12	0	0	,, ,,
,,	27 ..	12	0	0	,, ,,
,,	28 ..	12	0	0	,, ,,
,,	29 ..	11	15	0	dec. 5/-

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	43 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 0½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	118 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	180 6	180 6	184 3	196 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	87 0	87 0	87 3	87 2½	87 6	89 6	89 6	89 10½	86 11
1930	91 6	91 6	91 6	90 0	89 7½	88 0	87 7½	86 6	86 6	86 6	86 6	86 6	88 6½
1931	86 6	84 6	84 6	84 6	84 6	82 6	81 6	81 6	83 6	83 6	83 6	83 6	83 7
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1933	83 6	83 6	83 6	—	—	—	—	—	—	—	—	—	—

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